TM 11-5112

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

AZIMUTH AND RANGE INDICATOR IP-345/TPS-1D

DEPARTMENT OF THE ARMY • JANUARY 1956

WARNING
HIGH VOLTAGE

is used in the operation
of this equipment

DEATH ON CONTACT

may result if operating personnel
fail to observe
safety precautions.

Be careful not to contact high-voltage connections or any power connections when using this equipment. Turn off the power and discharge all high-voltage capacitors before making any test connections or doing any work inside the equipment.

EXTREMELY DANGEROUS VOLTAGES

exist in the following areas:
Top of chassis near cathode-ray tube
Bottom of chassis

TECHNICAL MANUAL

AZIMUTH AND RANGE INDICATORS IP–345/TPS–1D, IP–406/FPS–36, AND AZIMUTH-RANGE INDICATORS IP–345A/TPS–1D AND IP–406A/FPS–36

TM 11–5112
CHANGES No. 3

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *21 October 1958*

TM 11–5112, 20 January 1956, is changed as indicated, so that the manual also applies to the following equipment:

Nomenclature	*Order No.*
Azimuth-Range Indicator IP–345A/TPS–1D.	40561–PP–57–A2–A2
Azimuth-Range Indicator IP–406A/FPS–36.	39668–PP–58–A2–A2
Azimuth and Range Indicator IP–406/FPS–36.	Those equipments modified by MWO 11–1167–9.

Change the title of the manual to: AZIMUTH AND RANGE INDICATORS IP–345/TPS–1D, **IP–406/FPS–36, AND AZIMUTH-RANGE INDICATORS IP–345A/TPS–1D AND IP–406A/FPS–36.**

Note. The parenthetical reference to previous Changes (example: "page 1 of C 2") indicates that pertinent material was published in that Changes.

Page 1, chapter 1. Add the following "Note" below the title of chapter 1.

Note. Azimuth-Range Indicators IP–345A/TPS–1D and IP–406A/FPS–36 and Azimuth and Range Indicator IP–406/FPS–36 are similar to Azimuth and Range Indicator IP–345/TPS–1D. Information in this manual applies to all four sets unless otherwise specified.

Add "IP–345A/TPS–1D, IP–406/FPS–36 and IP–406A/FPS–36" after "IP–345/TPS–1D" in the following places:

Page ii, figure 1, caption.
Page 1, paragraph 1*a,* line 4.
Page 1, paragraph 3*c,* line 2.
Page 3, paragraph 8, heading.
Page 11, figure 7, caption.
Page 31, figure 21, caption.
Page 33, figure 22, caption.
Page 89, 90, figure 58, caption.

Add "(also 200 in IP–345A/TPS–1D, IP–406/FPS–36, and IP–406A/FPS–36)" in the following places:

Page 2, paragraph 4, right hand side, lines 3 and 7, after last word in sentence.
Page 22, paragraph 17*d*(2), line 3 from top of page, after "ranges."
Page 22, paragraph 17*e* (page 1 of C 1). Heading.
Page 23, paragraph 20, after "sweep ranges" in Function column corresponding to "RANGE switch (S604)" in Control column.
Page 56, paragraph 63*b,* line 17 from top of page after "ranges."

Page 1, paragraph 2. Delete subparagraphs *a* and *b* and substitute.

a. Unsatisfactory Equipment Reports. Fill out and forward DA Form 468 (Unsatisfactory Equipment Report), to the Commanding Officer, U. S. Army Signal Equipment Support Agency, Fort Monmouth, N. J., as prescribed in AR 700–38.

b. Report of Damaged or Improper Shipment. Fill out and forward DD Form 6 (Report of Damaged or Improper Shipment), as prescribed in AR 700–58 (Army), Navy Shipping Guide, Article 1850–4 (Navy), and AFR 71–4 (Air Force).

Page 1, paragraph 3. Delete subparagraph *a* and substitute.

a. Azimuth and Range Indicator IP–345/TPS–1D (fig. 1) is a remote plan position indicator (ppi) unit for use with Radio Set AN/TPS–1D. Azimuth and Range Indicator IP–406/FPS–36 (fig. 2.2) and Azimuth-Range Indicator IP–345A/TPS–1D (fig. 2.1) and IP–406A/FPS–36 (fig. 2.1) are remote ppi's for use with Radar Set AN/FPS–36. The latter three may be used with Radio Set AN/TPS–1D,

but cables are not supplied with the IP–406/FPS–36 and IP–406A/FPS–36. The purpose of all four of the remote ppi's is to repeat, at a remote point, target and identification friend or foe (iff) information appearing at the local indicator of the master radar set.

Page 1, paragraph 3*b*, line 4. Add "or Radar Set AN/FPS–36" after "Radio Set AN/TPS–1D."

Page 2, paragraph 4. Make the following changes:

Fourth from last line. Change "+1%" to "**±1%.**"

Third from last line. Change "+5%" and "+4%" to "±5%" and "±4%."

Add "IP–345A/TPS–ID and IP–406A/FPS–36 . . . . 103 lb" after last line.

Page 3, paragraph 6. Make the following changes:

Change "17¾" to "**16¼**" under "Height" column.

Change "5" to "**4.6**" under "Volume" column.

Add the following item to the table after "Azimuth and Range Indicator IP–345/TPS–1D."

Components	Rqr. No.	Height (in.)	Depth (in.)	Length (in.)	Volume (cu. ft.)	Unit wt (lb)
Azimuth-Range Indicators IP–345A/TPS–1D and TP–406A/FPS–36.	1	17⅞	27¼	17½	5	103

At the bottom of the table, change "Note" to "**Notes.**"

Number the existing note "1" and add the following:

2. The weights and dimensions for the IP–406/FPS–36 are the same as for the IP–345/TPS–1D. Only W5 is supplied with the IP–406/FPS–36 and IP–406A/FPS–36. The other four cables are supplied as part of Radar Set AN/FPS–36.

Page 4, figure 2. Change "CX–3704/U (25′0″)" to "**CX–3705/U (25′0″).**"

Page 5, paragraph 10. Insert "*a.*" in front of the first word in paragraph 10, and add the following:

b. The following is a list of running spares supplied with Azimuth-Range Indicators IP–345A/TPS–1D and IP–406A/FPS–36.

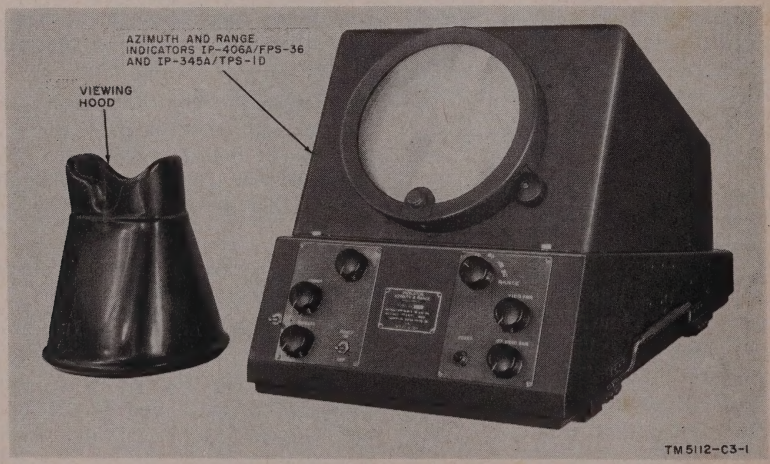


Figure 2.1. (Added) *Azimuth-Range Indicator IP–345A/TPS–1D and IP–406A/FPS–36 operating components. (Cables for IP–345A/TPS–1D are the same as in figure 2.)*

Figure 2.2. (Added) *Azimuth and Range Indicator IP–406/FPS–36. (Cable W5 only supplied.)*

Quantity	Description
1	Tube, type 6AU6WA
1	Tube, type 0B2WA
1	Tube, type 1X2A
1	Tube, type 5V4G
2	Tubes, type 6AU5GT
1	Tube, type 6X4WA
3	Tubes, type 12AT7WA
1	Tube, type 10WP7
1	Tube, type 5726/6AL5W
2	Tubes, type 6005/6AQ5W
12	Fuses, 4 amp, Bussman MDX, 125 v

Quantity	Description
6	Fuses, .3 amp, Bussman MDL, 250 v
6	Fuses, 1.6 amp, Bussman MDL, 125 v
6	Fuses, .8 amp, Bussman MDL, 250 v
6	Fuses, 2 amp, Bussman MDL, 125 v
6	Fuses, .5 amp, MIL type F02GR500B, 250 v
1	Dynamic Electronics filter No. B–11672–A (Z604).
1	Lamp GE No. 328 (white), MIL type MS25237–328.
1	Lamp GE No. 328 (red)
1	Lamp GE No. 47

Page 5. Add paragraph 10.1 after paragraph 10.

10.1. Differences in Models

Differences	Azimuth and Range Indicator IP–345/TPS–1D	Azimuth-Range Indicator IP–345A/TPS–1D	Azimuth and Range Indicator IP–406/FPS–36
Dimensions	16¼ in. high by 17¼ in. wide by 28 in. deep	17⅞ in. high by 17½ in. wide by 27¼ in. deep	16¼ in. high by 17¼ in. wide by 28 in. deep.
Weight	93 lb	103 lb	93 lb
Volume	4.6 cu ft	5 cu ft	4.6 cu ft
VIDEO-MTI-NORMAL switch.	Not included	Included	Included
200-mile range	Not included	Included	Included
JAN construction	No	Yes	No
Cables included	Yes	Yes [a]	No [b]
Provision for remote antenna control.	No	Yes	Yes

[a] Azimuth Range Indicator IP–406A/FPS–36 is identical to Azimuth Range Indicator IP–345A/TPS–ID except that cables other than W5 are not supplied.

[b] W5 only supplied.

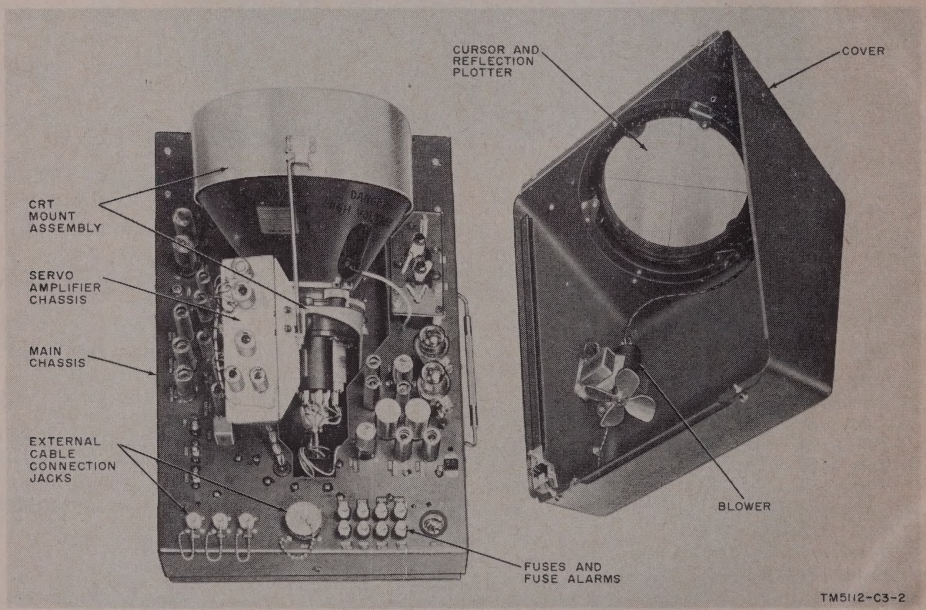


Figure 3.1. (Added) *Azimuth-Range Indicators IP–345A/TPS–1D, and IP–406A/FPS–36, cover removed.*

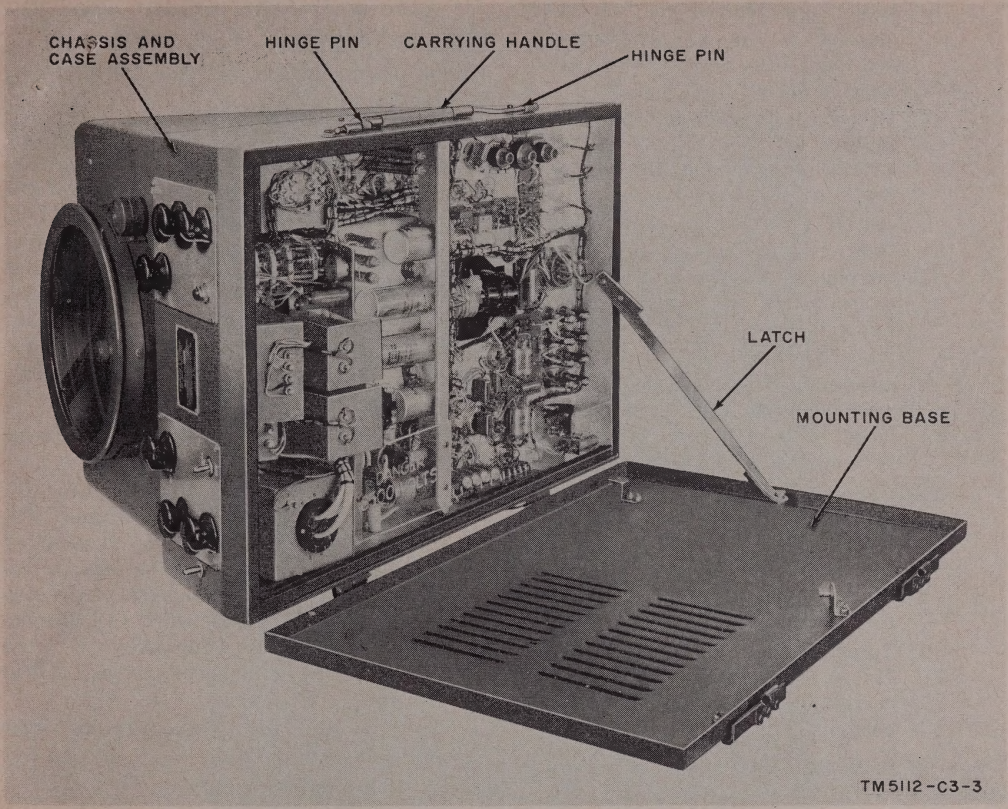


Figure 4.1. (Added) *Azimuth-Range Indicators IP–345A/TPS–1D, and IP–406A/FPS–36, mounting base opened.*

Page 9, paragraph 13. Make the following changes:

Subparagraph *a,* add the following after the second sentence: When either IP–406A/FPS–36, or IP–345A/TPS–1D, used with Radar Set AN/FPS–36, attach the mounting bracket for Antenna Control C–1894 to the mounting base before fastening the mounting base to the mounting surface. Follow instructions given in TM 11–5840–201–10, Radar Set AN/FPS–36, Operator's Manual.

Subparagraph *b.* Change the heading to: **Step-by-step Installation Instructions for IP–345/TPS–1D and IP–406/FPS–36 Only.**

Add subparagraph *b*.1 after subparagraph *b:*

b.1. *Step-by-step Installation Instructions for IP–345A/TPS–1D and IP–406A/FPS–36 Only.*

(1) Follow the instructions given in *b*(1) through (6) above.

(2) If the remote ppi is mounted on a wall or other vertical mounting surface, on the ceiling, or overhead, turn the two control identification plates around. Proceed as follows:

(*a*) Turn all controls fully counterclockwise and note knob arrow positions.

(*b*) Use an Allen wrench and loosen the set screws in the knobs on the INTENSITY, DIMMER, and MARKER controls. Remove the knobs.

(*c*) Loosen and remove the four 4–40 machine screws and lockwashers, and remove the control identification plate on the left.

(*d*) Follow the procedure given in (*a*) through (*c*) above for the RANGE, VIDEO GAIN, and IFF VIDEO GAIN controls, and removal of the control identification plate on the right.

(*e*) Interchange the two control identification plates, turn them over, and reinstall each one, so that it will read properly from the operating position.

(*f*) Remount all the knobs with the arrows pointing 180° from position noted in (*a*) above. The RANGE knob must point to 20.

(*g*) Loosen and remove the four machine screws and remove the equipment nameplate from the front of the equipment. Reinstall it, so that it can be read from the operating position.

(*h*) Turn the azimuth dial around (par. 72) so that the 180° position is nearest to the operator in operating position.

Page 12, paragraph 14*b*. Make the following changes:

Heading. Change "ANT/PS–1D" to **"AN/TPS–1D."**

Add subparagraph *b*.1 after subparagraph b(11) (*c*).

b.1. *Cable Installation with Radar Set AN/FPS–36.* When Azimuth and Range Indicator IP–406/FPS–36 or Azimuth-Range Indicators IP–345A/TPS–1D and IP–406A/FPS–36 are used with Radar Set AN/FPS–36, cables corresponding to W1, W2, W3, and W4 are supplied with the radar set. Refer to TM 11–5840–201–10 for cabling instructions.

Page 12, paragraph 14*c*, line 3. Add "or Azimuth-Range Indicator IP–345A/TPS–1D" after "IP–345/TPS–1D."

Page 13, figure 8. Make the following changes:

Add "OR IP–345A/TPS–1D" after "IP–345/TPS–1D" above the remote ppi in the lower left corner of the illustration.

Add "or IP–345A/TPS–1D" after "IP–345/TPS–1D" in the caption.

Page 17, paragraph 14. Add the following after subparagraph *e:*

f. Cable Installation, Radar Set AN/FPS–36. Four new cables are furnished with Radar Set AN/FPS–36 for connecting the IP–406/FPS–36, IP–406A/FPS–36, or IP–345A/TPS–1D to the Radar Set. These cables permit operation of the remote ppi at a distance up to 50 feet from the master radar. Cable W85 contains the additional conductors that are necessary for performing the repetition rate and the normal and mti switching functions. Refer to TM 11–5840–201–10 for cabling instructions.

Page 18, figure 13. Make the following changes:

Add a screwdriver adjustment to this illustration. Use R631 as a sample. The specific location is at the punched-out grounding lug that can be seen on the chassis at the right-hand side of the electron tube (V613 in figure 44) immediately above R631. Draw an arrow to this screwdriver adjustment and add callout R1647.

Caption. Add "and IP–406/FPS–36" after "IP–345/TPS–1D."

Add the following note:

NOTE:

RESISTOR R1647 IS IN IP–406/FPS–36 BUT NOT IN IP–345/TPS–1D.

Page 19, paragraph 17*b*. Make the following changes:

Heading. Add "on IP–345/TPS–1D and IP–406/FPS–36 Only."

Add subparagraph *b*.1 after subparagraph *b* (14):

b.1. *Mechanical Focusing and Centering Alignment on IP–345A/TPS–1D and IP–406A/FPS–36 Only.* The focusing and centering magnet assemblies on the IP–345A/TPS–1D are as shown in figure 14.1. To adjust one of these magnets, hold the protruding rubber-covered magnet ringend corresponding to the direction in which the ring is to be rotated and push in that direction. On each magnet assembly, the protruding ringends should be on opposing sides of the crt

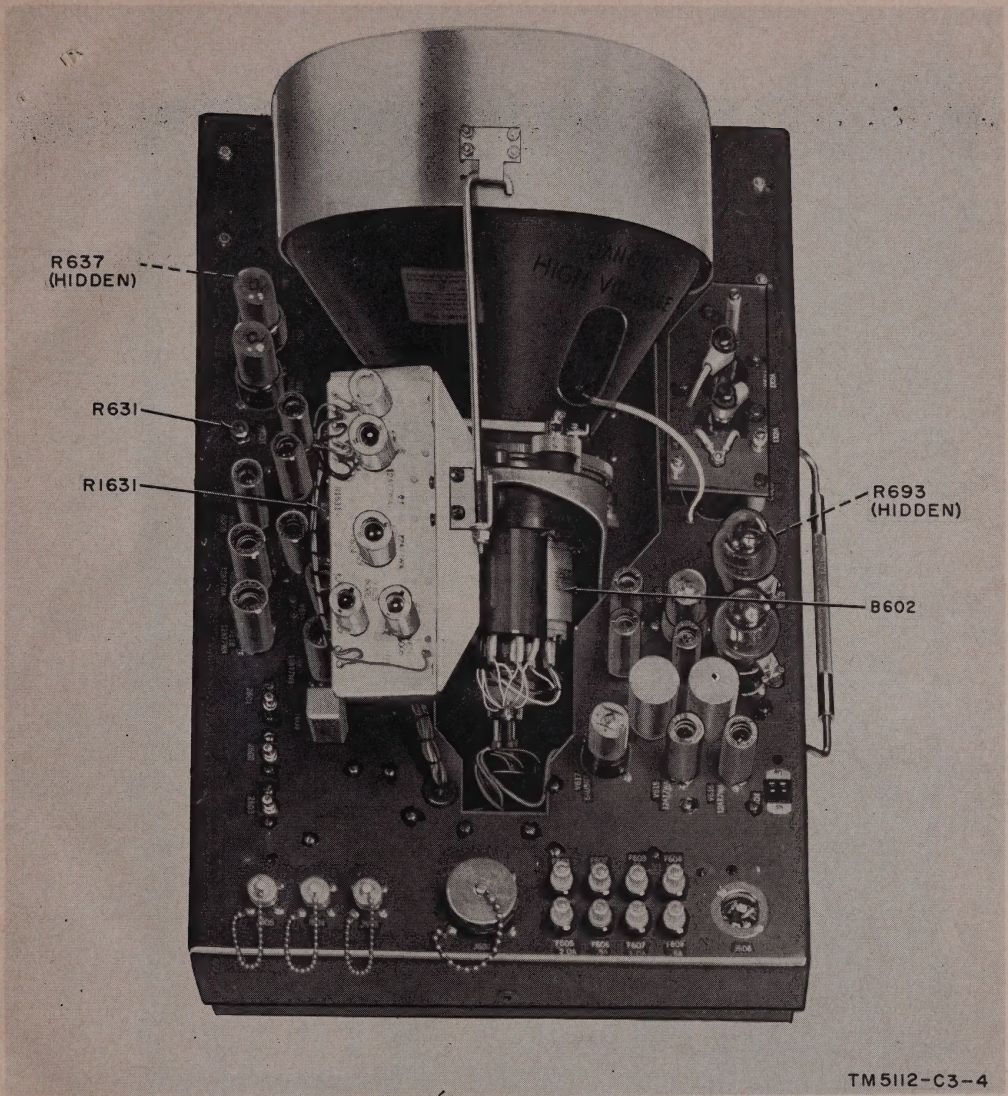


Figure 13.1. (Added) *Azimuth-Range Indicators IP–345A/TPS–1D, and IP–406A/FPS–36, screwdriver adjustments on top.*

neck as a starting reference for their adjustment.

(1) Check to see that the focusing and centering magnet assemblies are in place as directed in paragraph 72*e*.

(2) Proceed as directed in *b*(2) through (14) above with the following consideration: wherever reference is made to adjustment of a knurled knob, substitute adjustment of a magnet ring in the corresponding assembly by the procedure described above.

(3) Finger-tighten the clamping screws on the magnet assemblies.

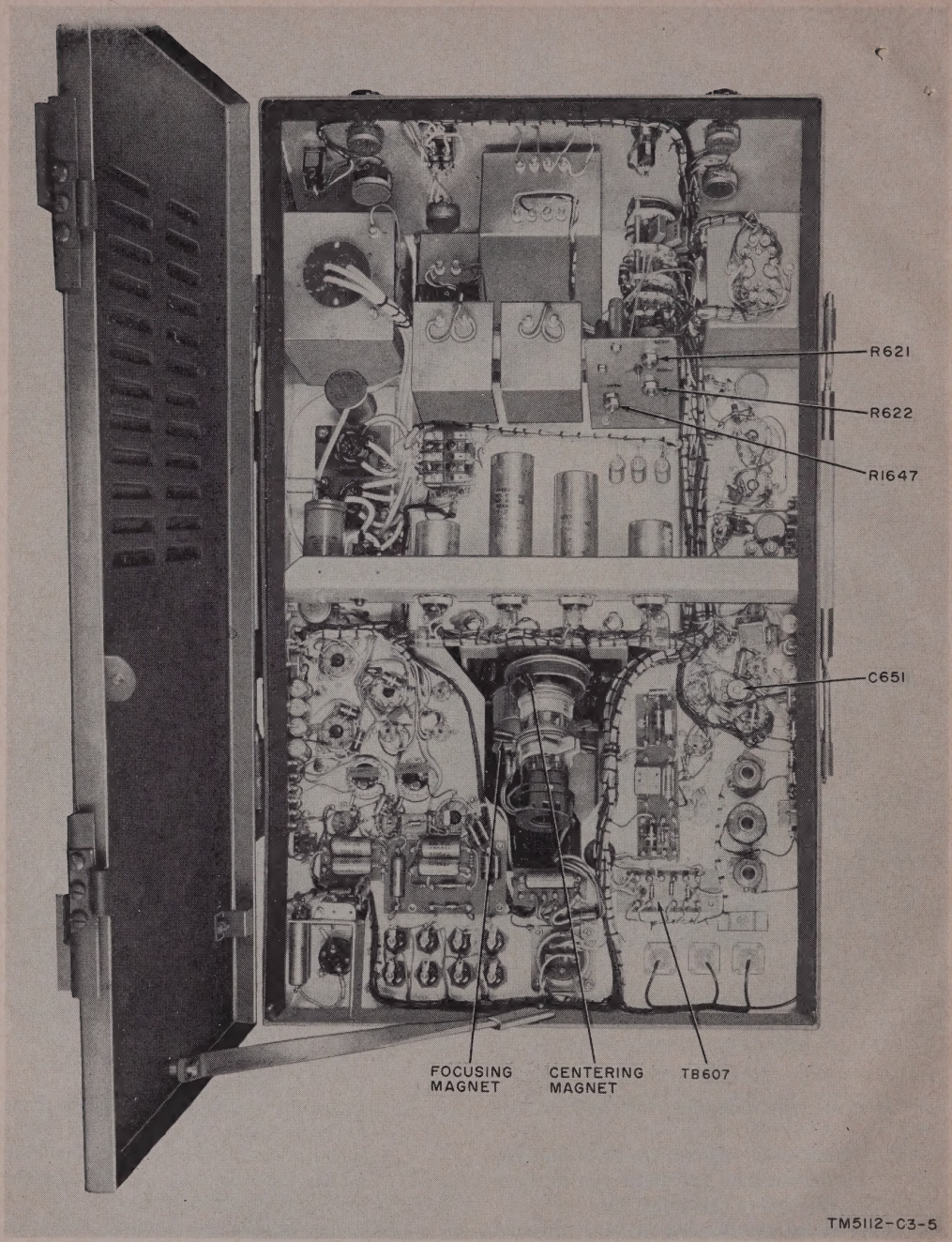


Figure 14.1. (Added) *Location of under-chassis adjustment points and magnet assemblies on Azimuth-Range Indicators IP–345A/TPS–1D and IP–406A/FPS–36.*

Page 21, paragraph 17*d*. Add the following after the first sentence:

Terminal board TB607 (fig. 14.1) in IP–345A/TPS–1D and IP–406A/FPS–36 is the same as panel F; therefore, for all references to panel F, substitute TB607 when working with the IP–345A/TPS–1D or IP–406A/FPS–36.

Page 22, paragraph 17. Subparagraph *e*, as superseded by C 1, 5 March 1956 (Superseded).

e. 80-, 160-, and 200-mile Gate Length Adjustments. With a trigger input supplied from the master radar set and the remote ppi energized, proceed as follows:

(1) Place the RANGE switch in the 80 position and display 10-mile markers.

(2) Adjust 80-mile gate-length control R622 (fig. 47) and (fig. 47.1 for IP–406A/FPS–36 and IP–345A/TPS–1D and fig. 47.2 for IP–406/FPS–36) so that the sweep ends just beyond the 80-mile marker.

(3) Place the RANGE switch in the 160 position and display the 10-mile markers.

(4) Adjust 160-mile gate length control R621 (fig. 13 for IP–345/TPS–1D and IP–406/FPS–36 and fig. 14.1 for IP–345A/TPS–1D and IP–406A/FPS–36) so that the sweep ends just beyond the 160-mile marker.

Note. These adjustments must be made in the order given because the controls interact.

(5) Place the RANGE switch in the 200 position and display either the 10- or 25-mile markers.

(6) Adjust the 200-mile gate length control R1647 (fig. 13 for IP–406/FPS–36 and fig. 14.1 for IP–345A/TPS–1D and IP–406A/FPS–36) so that the sweep ends just beyond the 200-mile markers.

Subparagraph *f*(4), line 3. Delete "(80, 40, and 20)."

Page 22, paragraph 18*c*, line 2. Delete "four."

Page 23, paragraph 20. Make the following changes:

Heading. After "(fig. 17)," add (fig. 17.1 for IP–345A/TPS–1D and IP–406A/FPS–36 and fig. 17.2 for IP–406/FPS–36).

In "Control" column, under "RANGE switch," add "S606 in IP–406/FPS–36."

In "Function" column, after "160-mile," add "or 200-mile in IP–345A/TPS–1D, IP–406/FPS–36 and IP–406A/FPS–36. Also changes repetition rate in 200 position when used with Radar Set AN/FPS–36."

Add the following item to the end of the table:

Control	Function
VIDEO MTI-NORMAL switch [a]	Controls master radar mti-normal circuits when REMOTE-LOCAL switch at master radar is in REMOTE position.

Add the following footnote beneath table:

[a]Refers to IP–345A/TPS–1D, IP–406/FPS–36 and IP–406A/FPS–36 only.

Page 25, paragraph 22*c*, last line. Add "(fig. 18.1 for IP–345A/TPS–1D)" after "(fig. 18)."

Page 30, paragraph 34, heading. Change "Azimuth and Range Indicator IP–345/TPS–1D to **"Remote Ppi."**

Page 31, paragraph 36*b*. Add the following after the last sentence: The IP–345A/TPS–1D and IP–406A/FPS–36 have received this treatment at the factory.

Page 32, paragraph 40. Make the following changes:

Last line. Change "remote ppi" to **"IP–345/TPS–1D and IP–406/TPS–1D."**

Add the following: For the same information, as applicable to the IP–345A/TPS–1D and IP–406A/FPS–36, refer to figure 23.1.

Page 35, paragraph 42, line 3. Change "6 AU6WA" to **"6AU6WA."**

Page 36, paragraph 46. Make the following changes:

Add item "8.1[a]" after "8."

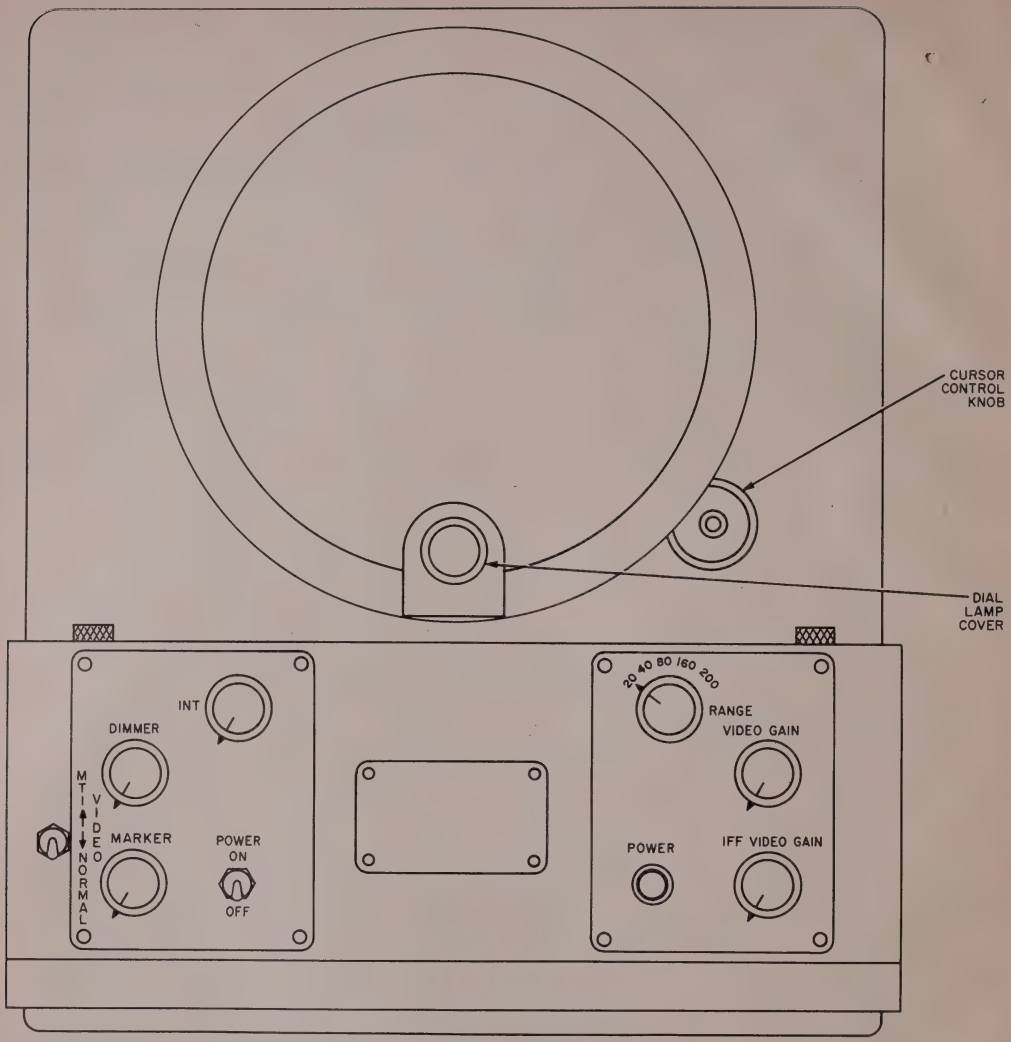


Figure 17.1. (Added) *Azimuth-Range Indicators IP–345A/TPS–1D and IP–406A/FPS–36, operating controls.*

Item No.	Item	Action or condition	Normal indication	Corrective measures
8.1 [a]	VIDEO MTI NORMAL	Set at NORMAL position.		

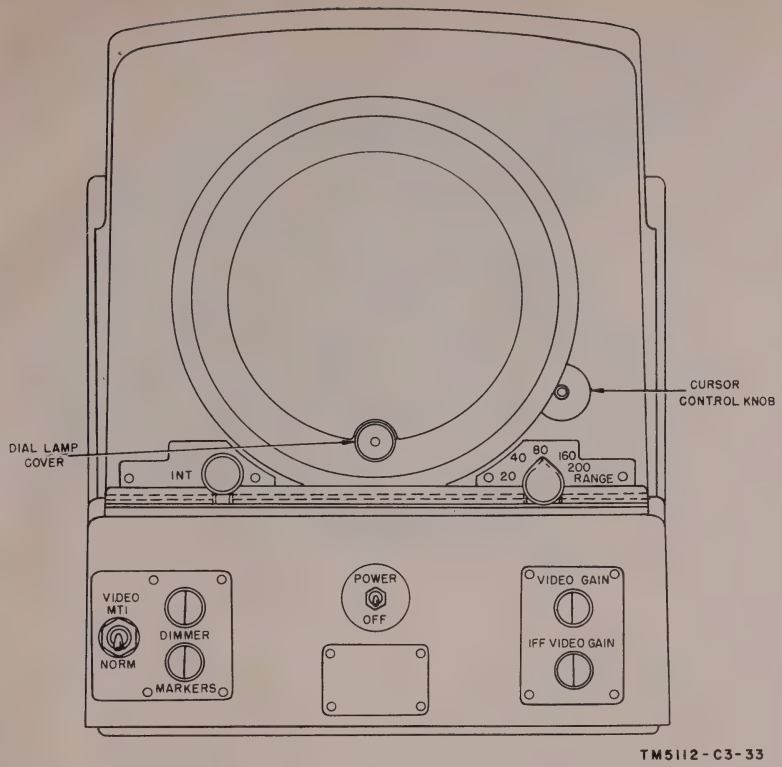


Figure 17.2. (Added) *Azimuth and Range Indicator IP–406/FPS–36, operating controls.*

Delete all column entries for item No. 10 and substitute—

Item No.	Item	Action or condition	Normal indication	Corrective measures
10	POWER-OFF switch.	Turn to the POWER position, then listen carefully.	Pilot lamp I 601 lights [b]_____	Check fuses F601, F602, and F604. Inspect J601 and P601 and their connections.
			Blower motor starts running__	Check fuse F603.
			Relay K601 pulls in approximately 10 seconds after POWER-OFF switch is turned on. Relay makes a barely audible click.	Check fuse F605 and interlock S603. Check V603 and V604.

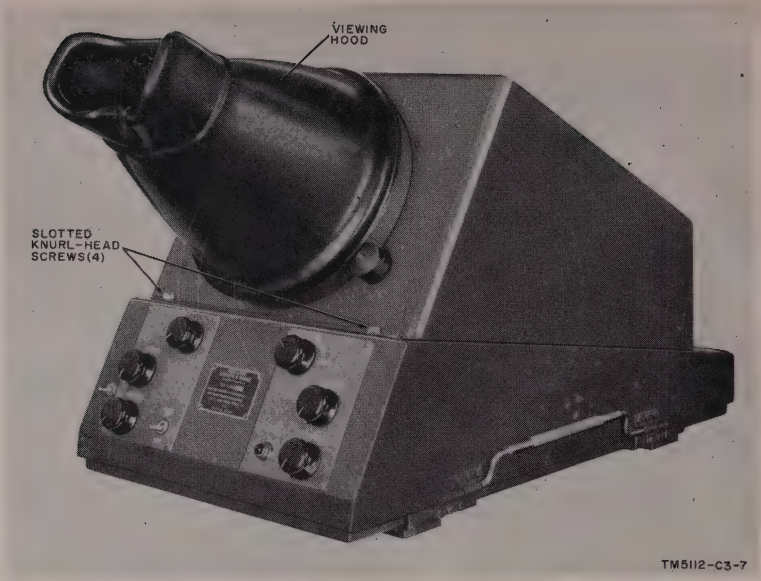


Figure 18.1. (Added) *Azimuth and Range Indicator IP–345A/TPS–1D, viewing hood attached.*

In "Action or condition" column, under item No. 13, add: Turn to 200 position[a].

In "Normal indication" column, under item No. 13, add: Twenty 10-mile markers or eight 50,000-yard markers displayed[a].

In "Corrective measures" column, under item No. 13, add: Check sweep step and slope adjustments (par. 17).

Add item "15.1[a]" after "15."

Item No.	Item	Action or condition	Normal indication	Corrective measures
15.1[a]	VIDEO MTI-NORMAL switch	Set to MTI position	Ground clutter disappears on cathode-ray tube, leaving only moving targets when used with mti-equipped master radar set.	Check master radar set for normal operation. Check cable W4 or W85 (whichever is used) and its connections. Troubleshooting by field maintenance personnel is required.

Add the following footnotes at the end of the table:

[a] Refers to IP–406/FPS–36, IP–406A/FPS–36, and IP–345A/TPS–1D only.

[b] Refers to IP–345A/TPS–1D and IP–406A/FPS–36 only.

Page 39, paragraph 48*a*, line 4. Change "V608" to: **V608A.**

Page 40. Add paragraph 48.1 after paragraph 48.

48.1. Circuit Differences

The following are the circuit differences between the IP–345/TPS–1D and the IP–345A/TPS–1D, the IP–406/FPS–36, or the IP–406A/FPS–36:

Subparagraph *a* below gives the differences between the IP–345/TPS–1D and both the IP–345A/TPS–1D, the IP–406/FPS–36 and the IP–406A/FPS–36.

Subparagraph *b* below gives additional differ-

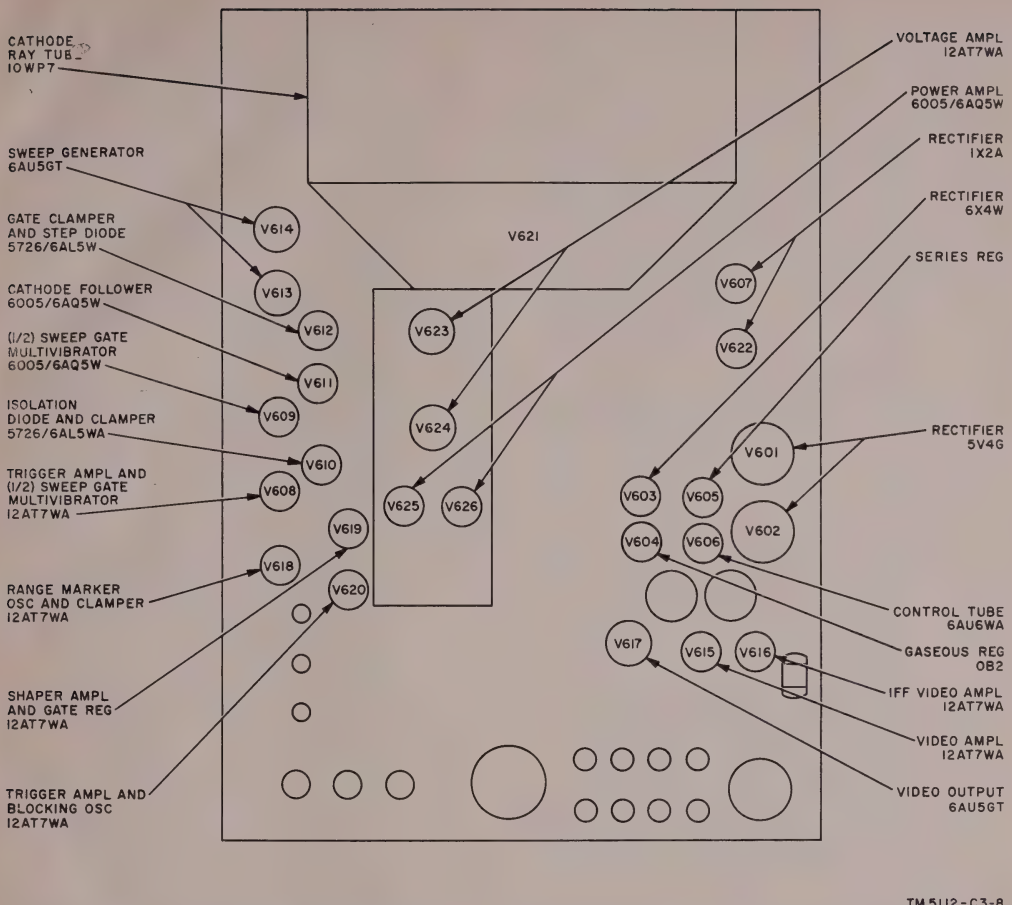


Figure 23.1. (Added) *Azimuth-Range Indicators IP–345A/TPS–1D, and IP–406A/FPS–36, tube location drawing.*

ences between the IP–345/TPS–1D or the IP–406/FPS–36 and the IP–345A/TPS–1D or the IP–406A/FPS–36.

a. Comparison of IP–345/TPS–1D with IP–345A/TPS–1D, IP–406/FPS–36 and IP–406A/FPS–36.

(1) *Sweep gate multivibrator.* When the RANGE switch is turned to the 200 position, 200-mile gate length potentiometer R1647 is connected in series with the timing resistors (R620, R621, and R622) that determine the cutoff period of V609 (the gate length). Potentiometer R1647 adds resistance to this RC circuit that extends the gate length for the 200-mile range. Potentiometer R1647 is adjusted to end the sweep just beyond the 200-mile range marker.

(2) *Sweep generator.* When the RANGE switch is turned to the 200 position, feedback capacitor C667 is connected into the sweep generator circuit. This capacitor, together with the associated resistance network, determines the slope of the grid voltage rise of sweep generator tubes V613 and V614 and, therefore, determines the sweep time.

(3) *Step to sawtooth ratio.* The linearity of the sweep on the ppi cathode-ray tube is determined by the ratio between the step portion and the sawtooth portion of the sweep voltage wave form with an optimum ratio for each sweep length. Section 2 of RANGE switch S606 (S604 in IP–345A/TPS–1D) selects the shunt resistance across the deflection coil to obtain the correct proportion of step to sawtooth for each range. When switched to the 200 position, the joint resistance of R645 and R649 in parallel is shunted across deflection coil L609.

(4) *Intensity compensation.* Potentiometer R1648 is added to the intensity compensation circuits to compensate for slow sweep speed at the 200-mile range. This helps to maintain a constant sweep brightness. When the RANGE switch is in the 200 position, section 5A connects R1648 in the voltage divider network that supplies the potential for the No. 1 grid of the cathode-ray tube.

(5) *Marker selection.* For the 200-mile sweep range, additional contacts are included on sections 4B and 5B of the RANGE switch. These contacts are connected in parallel with the 80- and 160-mile contacts to facilitate display of the 25-mile markers when the 200-mile range is used.

(6) *Remote control.* When used with Radar Set AN/FPS–36, provisions are made to control the display of both indicators, in some respects, from the remote indicator. This control is effective only when the LOCAL-REMOTE switch in Pulse Generator TD–169/TPS–1D (a unit of Radar Set AN/FPS–36) is in the REMOTE position. Switch S605 in the IP–406/FPS–36, IP–406A/FPS–36 and IP–345A/TPS–1D is the VIDEO, MTI-NORMAL switches that control the display of fixed and moving targets on the indicators. When the switch is in the MTI position, the return echoes from fixed targets are greatly reduced. When the switch is in the NORMAL position, all targets are displayed. In addition, section 4A of the RANGE switch changes the repetition rate of the master radar set when the RANGE switch is placed in the 200 position. This is done by grounding lead G of J602 which, in turn, causes a relay in the pulse generator to be energized, switching the repetition rate from 400 pps to 325 ± 10 pps.

b. Additional Differences Between IP–345/TPS–1D or IP–406/FPS–36 and IP–345A/TPS–1D or IP–406/FPS–36.

(1) Tube sections V620A and V620B have the tube pin numbers reversed.

(2) The value of capacitor C647 in the trigger amplifier circuit is changed from .01 microfarad to .047 microfarad.

(3) The reference symbols for capacitor C603 in video amplifier V615A and C626 in video amplifier V615B have been interchanged. The value of both capacitors is changed from 20 microfarads to 25 microfarads.

(4) The value of capacitor C657 in voltage amplifier V623A is changed from .022 microfarad to .033 microfarad.

(5) The value of capacitor C666 across the output of the power amplifier is changed from .22 microfarad to .47 microfarad. Capacitor C664 that was in parallel with C666 is removed.

(6) The value of capacitor C604 in rectifier V602 circuit is changed from 80 microfarads to 90 microfarads.

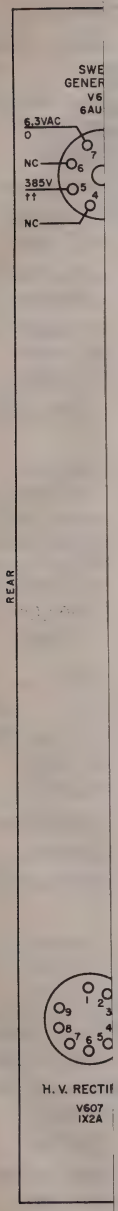
(7) The value of capacitors C607 and C638 in rectifier V603 circuit is changed from 20 microfarads to 25 microfarads.

(8) The bucking winding between terminals 13 and 14 of transformer T601 is no longer needed and is omitted. The voltage across the primary of T602 is 115 volts instead of 109 volts.

Page 41, paragraph 49*b*. Make the following changes:

Line 15. After "grid," add: "voltage."

Line 28. After "adjusted," add: In the IP–345A/TPS–1D, IP–406/FPS–36, and


SWE
GENER
V6
6AU
6.3VAC
0
NC
385V
NC
REAR
H. V. RECTI
V607
1X2A

(3) *Step to sawtooth ratio.* The linearity of the sweep on the ppi cathode-ray tube is determined by the ratio between the step portion and the sawtooth portion of the sweep voltage wave form with an optimum ratio for each sweep length. Section 2 of RANGE switch S606 (S604 in IP–345A/TPS–1D) selects the shunt resistance across the deflection coil to obtain the correct proportion of step to sawtooth for each range. When switched to the 200 position, the joint resistance of R645 and R649 in parallel is shunted across deflection coil L609.

(4) *Intensity compensation.* Potentiometer R1648 is added to the intensity compensation circuits to compensate for slow sweep speed at the 200-mile range. This helps to maintain a constant sweep brightness. When the RANGE switch is in the 200 position, section 5A connects R1648 in the voltage divider network that supplies the potential for the No. 1 grid of the cathode-ray tube.

(5) *Marker selection.* For the 200-mile sweep range, additional contacts are included on sections 4B and 5B of the RANGE switch. These contacts are connected in parallel with the 80- and 160-mile contacts to facilitate display of the 25-mile markers when the 200-mile range is used.

(6) *Remote control.* When used with Radar Set AN/FPS–36, provisions are made to control the display of both indicators, in some respects, from the remote indicator. This control is effective only when the LOCAL-REMOTE switch in Pulse Generator TD–169/TPS–1D (a unit of Radar Set AN/FPS–36) is in the REMOTE position. Switch S605 in the IP–406/FPS–36, IP–406A/FPS–36 and IP–345A/TPS–1D is the VIDEO, MTI-NORMAL switches that control the display of fixed and moving targets on the indicators. When the switch is in the MTI position, the return echoes from fixed targets are greatly reduced. When the switch is in the NORMAL position, all targets are displayed. In addition, section 4A of the RANGE switch changes the repetition rate of the master radar set when the RANGE switch is placed in the 200 position. This is done by grounding lead G of J602 which, in turn, causes a relay in the pulse generator to be energized, switching the repetition rate from 400 pps to 325 ± 10 pps.

b. Additional Differences Between IP–345/TPS–1D or IP–406/FPS–36 and IP–345A/TPS–1D or IP–406/FPS–36.

(1) Tube sections V620A and V620B have the tube pin numbers reversed.

(2) The value of capacitor C647 in the trigger amplifier circuit is changed from .01 microfarad to .047 microfarad.

(3) The reference symbols for capacitor C603 in video amplifier V615A and C626 in video amplifier V615B have been interchanged. The value of both capacitors is changed from 20 microfarads to 25 microfarads.

(4) The value of capacitor C657 in voltage amplifier V623A is changed from .022 microfarad to .033 microfarad.

(5) The value of capacitor C666 across the output of the power amplifier is changed from .22 microfarad to .47 microfarad. Capacitor C664 that was in parallel with C666 is removed.

(6) The value of capacitor C604 in rectifier V602 circuit is changed from 80 microfarads to 90 microfarads.

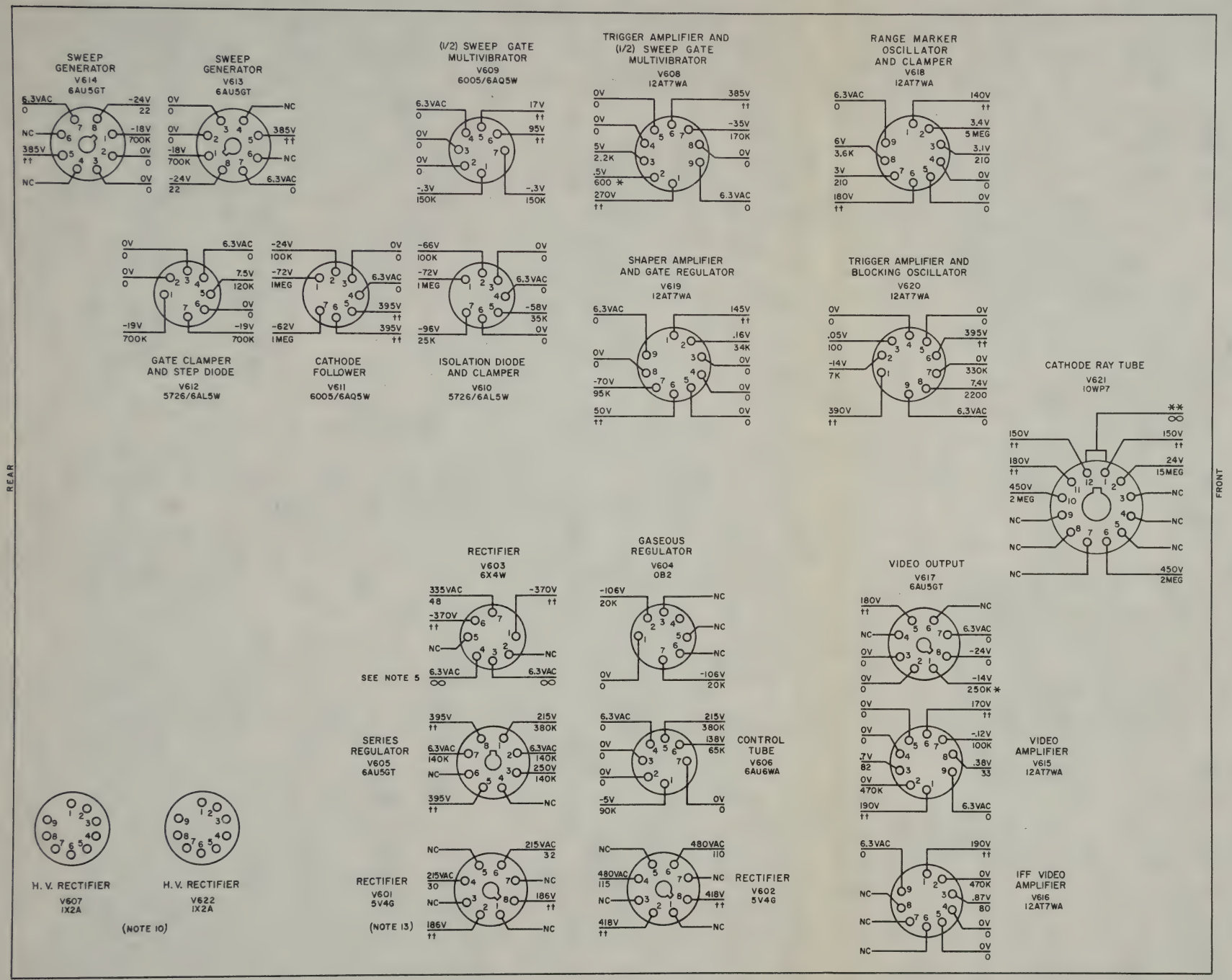
(7) The value of capacitors C607 and C638 in rectifier V603 circuit is changed from 20 microfarads to 25 microfarads.

(8) The bucking winding between terminals 13 and 14 of transformer T601 is no longer needed and is omitted. The voltage across the primary of T602 is 115 volts instead of 109 volts.

Page 41, paragraph 49*b*. Make the following changes:

Line 15. After "grid," add: "voltage."

Line 28. After "adjusted," add: In the IP–345A/TPS–1D, IP–406/FPS–36, and



NOTES:

1. ALL READINGS MEASURED TO CHASSIS WITH 20,000 OHMS-PER-VOLT METER.
2. VOLTAGE READINGS ABOVE LINE. RESISTANCE READINGS BELOW LINE.
3. VOLTAGES ARE POSITIVE DC UNLESS OTHERWISE SPECIFIED.
4. RESISTANCE MEASUREMENTS ARE TAKEN WITH EXTERNAL CABLES DISCONNECTED.
5. 6.3V AC BETWEEN PINS SO MARKED. RESISTANCE IS READ TO CHASSIS.
6. ** DO NOT MEASURE HIGH VOLTAGE.
7. †† RESISTANCE VARIES BECAUSE OF ELECTROLYTIC CAPACITORS IN THE CIRCUIT.
8. ALL CONTROLS SET FULLY CLOCKWISE EXCEPT [RANGE] SWITCH IS SET IN [20] POSITION.
9. READINGS ON V621 TAKEN WITH SOCKET REMOVED FROM TUBE.
10. DO NOT MEASURE VOLTAGES AND RESISTANCES AT RECTIFIERS V607 AND V622. TERMINALS ARE COATED WITH INSULATING MATERIAL.
11. NC DENOTES NO CONNECTION.
12. * RESISTANCE VARIES BECAUSE OF CRYSTAL DIODE IN CIRCUIT.
13. WHERE DC VOLTAGES ARE SUPERIMPOSED ON TERMINALS HAVING AC FILAMENT VOLTAGES THE DC VOLTAGES ARE GIVEN.

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Figure 42.1. (Added) *Main chassis, Azimuth-Range Indicators IP–345A/TPS–1D and IP–406A/FPS–36, tube socket voltage and resistance diagram.*

IP–406A/FPS–36 which have 200 positions, resistor R1647 is the potentiometer by which the maximum (200-mile) gate length is adjusted.

Page 42, figure 25. Make the following changes:

Add one switch position contact labeled "200 SEE NOTE 1" after "160" on RANGE switch "S604 SECT 3."

Connect potentiometer R1647 between this contact and the contact for 160 position. Use R621 as sample.

Connect the arm of the potentiometer to the junction of R1647 and R621.

Add value of "1 MEG" for R1647. Add "200 MILE GATE LENGTH SEE NOTE 1" to left of R1647.

Add the following:

NOTES:

1. REFERS TO IP–345A/TPS–1D AND IP–406A/FPS–36 ONLY.

2. IP–406/FPS–36 RANGE SWITCH CHANGES ARE THE SAME AS FOR IP–345A/TPS–1D AND IP–406A/FPS–36 EXCEPT THAT REFERENCES SYMBOL OF SWITCH IS S606.

Add "3,300 SEE NOTE 1" beneath "R611, 10K."

Page 44, figure 27. Make the following changes:

Add one switch position contact labeled "200 SEE NOTE 1" after "160" on RANGE switch "S604 SECT 2."

Connect jumper between this contact and the contact for 80 position.

Add the following:

NOTES:

1. REFERS TO IP–345A/TPS–1D AND IP–406A/FPS–36 ONLY.

2. RANGE SWITCH CHANGES TO IP–345A/TPS–1D, IP–406/FPS–36 AND IP–406A/FPS–36 ARE THE SAME. IP–406/FPS–36 REFERENCE SYMBOL IS S606.

Add one switch position contact labeled "200 SEE NOTE 1" after "160" on RANGE switch "S604 SECT 1."

Connect capacitor C667 between this contact and the junction of C616 and C617. Label capacitor "C667 SEE NOTE 1 5100."

Page 45, paragraph 51*d*, left column, line 21. Change "R619" to: R1619.

Page 45. Add paragraph 51.1 after paragraph 51.

51.1. Repetition Rate Switching

Because of the recovery time required by the indicator circuits, the modified remote ppi operating with a 200-mile sweep cannot be effectively operated at the 400-pps repetition rate normally used in Radio Set AN/TPS–1D. Radar Set AN/FPS–36, however, does have provisions for switching the repetition rate to 325 ±10 pps when used with a 200-mile sweep range. Contacts on section 4 of RANGE switch S606 (fig. 59.2 and S604, fig. 59.1 for IP–345A/TPS–1D and IP–406A/FPS–36) that are closed when the RANGE switch is in the 200 position, operate a relay in Pulse Generator TD–169/TPS–1D (a unit of Radar Set AN/FPS–36) to change the master radar set repetition rate from 400 to 325 ±10 pps. (See TM 11–5840–201–10.)

Page 46, figure 28. Make the following changes:

Add one switch position contact labeled "200 SEE NOTE 1" after "160" on each section shown of RANGE switch S604. On each, connect jumper between this contact and the contact for position "160."

Add the following:

NOTES:

1. REFERS TO IP–345A/TPS–1D AND IP–406A/FPS–36 ONLY.

2. IP–406/FPS–36 RANGE SWITCH CHANGES ARE THE SAME AS FOR IP–345A/TPS–1D AND IP–406A/FPS–36 EXCEPT THAT REFERENCE SYMBOL OF SWITCH IS S606.

Page 46, paragraph 54*a*. Add the following after the last sentence:

Note that in the IP–345A/TPS–1D and IP–406A/FPS–26, V620A and V620B are switched, so that pins 6, 7, and 8 correspond to trigger amplifier V620A, and pins 1, 2, and 3 correspond to blocking oscillator V620B.

Page 47, figure 29. Make the following changes:

Add ".047 SEE NOTE 1" beneath "C647 .01."

Add the following:

NOTES:

1. REFERS TO IP–345A/TPS–1D AND IP–406A/FPS–36 ONLY.

2. IN IP–345A/TPS–1D, V620 PINS 1, 2, AND 3 ARE INTERCHANGED WITH PINS 6, 7, AND 8.

Page 48, figure 30. Make the following changes:

Add "C626 SEE NOTE 25 UF" beneath "C603 20 UF."

Add the following:

NOTES:

REFERS TO IP–345A/TPS–1D AND IP–406A/FPS–36 ONLY.

Page 49, figure 31. Make the following changes:

Add "C603 SEE NOTE 25 UF" above "C626 20 UF."

Add the following:

NOTES:

REFERS TO IP–345A/TPS–1D AND IP–406A/FPS–36 ONLY.

Page 52, figure 34. Make the following changes:

Add ".033 SEE NOTE" alongside ".022" under "C657."

Add the following:

NOTES:

REFERS TO IP–345A/TPS–1D AND IP–406A/FPS–36 ONLY.

Add ".47 UF SEE NOTE" beneath "C666 .22 UF."

Add "DELETE SEE NOTE" beneath "C664 .22 UF."

Page 53, figure 35. Make the following changes:

Add "90 UF SEE NOTE" beneath "C604 80 UF."

Add the following:

NOTES:

REFERS TO IP–345A/TPS–1D AND IP–406A/FPS–36 ONLY.

Page 54, figure 36. Make the following changes:

Add "25 UF SEE NOTE" beneath "C607 20 UF" and "C638 20 UF."

Add the following:

NOTES:

REFERS TO IP–345A/TPS–1D AND IP–406A/FPS–36 ONLY.

Page 56, paragraph 63*b*. Add the following sentence at the end of subparagraph *b:* Resistor R1648 is used in the 200-mile range circuit of the IP–345A/TPS–1D, the IP–406/FPS–36 and the IP–406A/FPS–36.

Page 57, figure 38. Make the following changes:

Delete contact numbers on RANGE switch S604, S–5A.

Add one switch position contact labeled "200 SEE NOTE 1" after "160" on RANGE switch S604, S–5A.

Connect resistor R1648 between this contact and junction of R682 and R683. Label resistor "R1648 SEE NOTE 1 4300."

Renumber switch contacts as shown in figure 59.1.

Add the following:

NOTES:

1. REFERS TO IP–345A/TPS–1D AND IP–406A/FPS–36 ONLY.

2. RANGE SWITCH CHANGES FOR THE IP–406/FPS–36 ARE THE SAME AS FOR IP–345A/TPS–1D AND IP–406A/FPS–36 EXCEPT THAT REFERENCE SYMBOL IS S606.

Page 57, paragraph 63*c*, second from last line on page 57. Add "(not present in IP–345A/TPS–1D and IP–406A/FPS–36)" after "This winding."

Page 58, figure 39. Change "NOTE" to **"NOTES."**

Designate the existing note "1", and add the following:

2. TRANSFORMER WINDING BETWEEN TERMINALS 13 AND 14 IN T601 IS NOT PRESENT IN IP–345A/TPS–1D and IP–406A/FPS–36.

Page 61, paragraph 68. Make the following changes:

Add subparagraphs *b*.1 and *b*.2 after subparagraph *b:*

b.1. Figure 59.1, Azimuth-Range Indicator IP–345A/TPS–1D, and IP–406A/FPS–36, schematic diagram.

b.2. Figure 59.2, Azimuth and Range Indicator IP–406/FPS–36, schematic diagram.

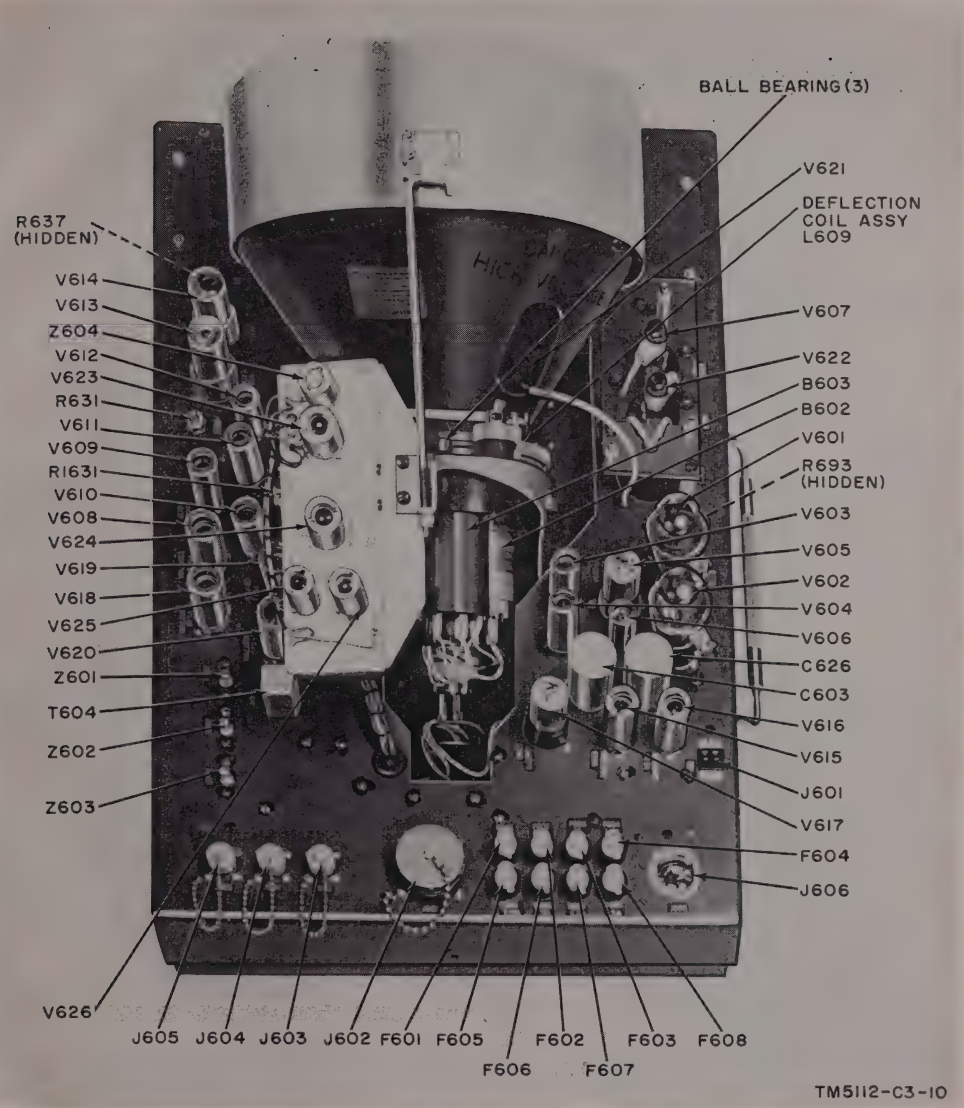


Figure 44.1. (Added) *Top chassis view, Azimuth-Range Indicators IP–345A/TPS–1D and IP–406A/FPS–36, parts location.*

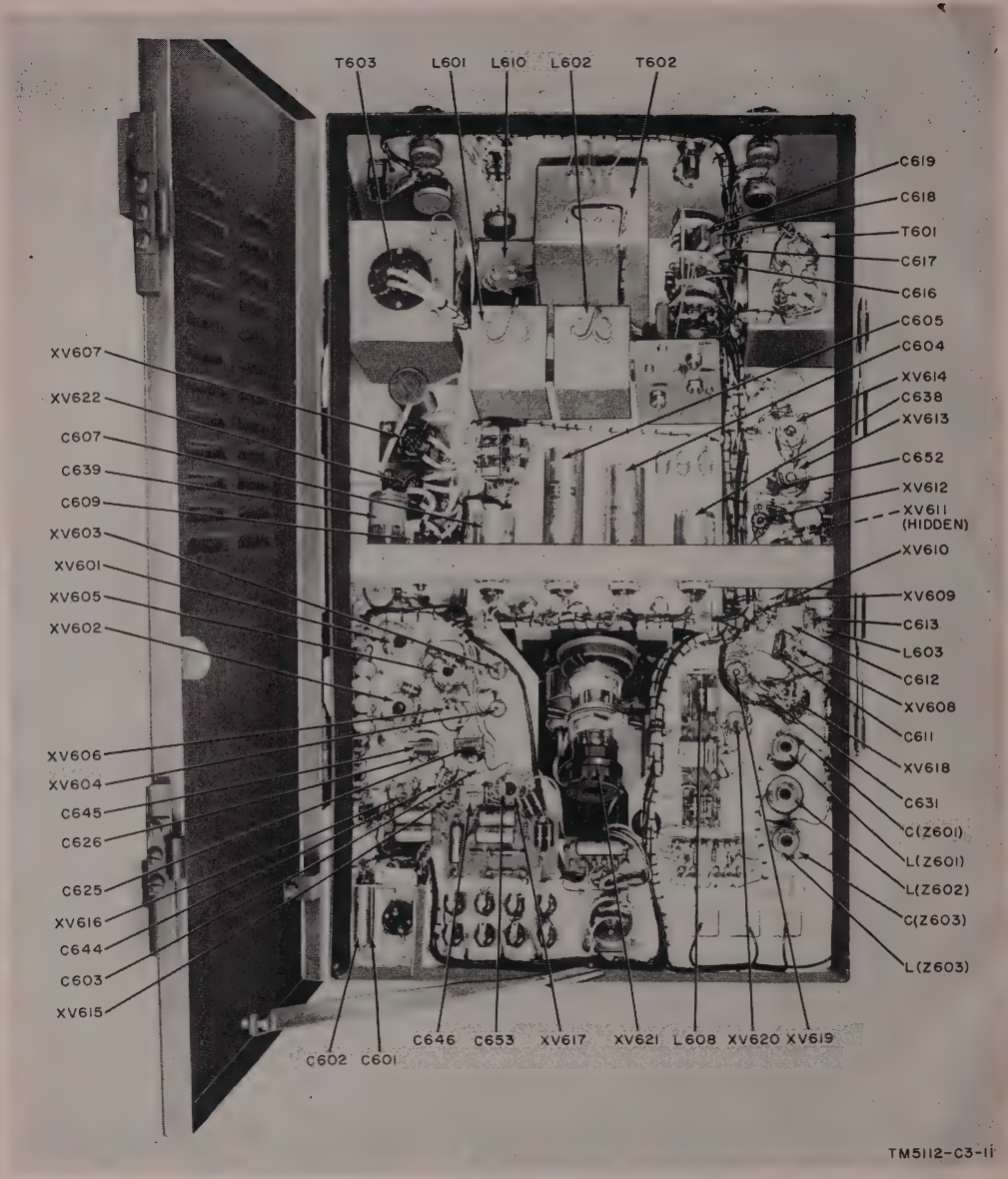


Figure 45.1. (Added) *Under-chassis view, Azimuth-Range Indicators IP–345A/TPS–1D and IP–406A/FPS–36, location of tube sockets, transformers, inductors, and capacitors.*

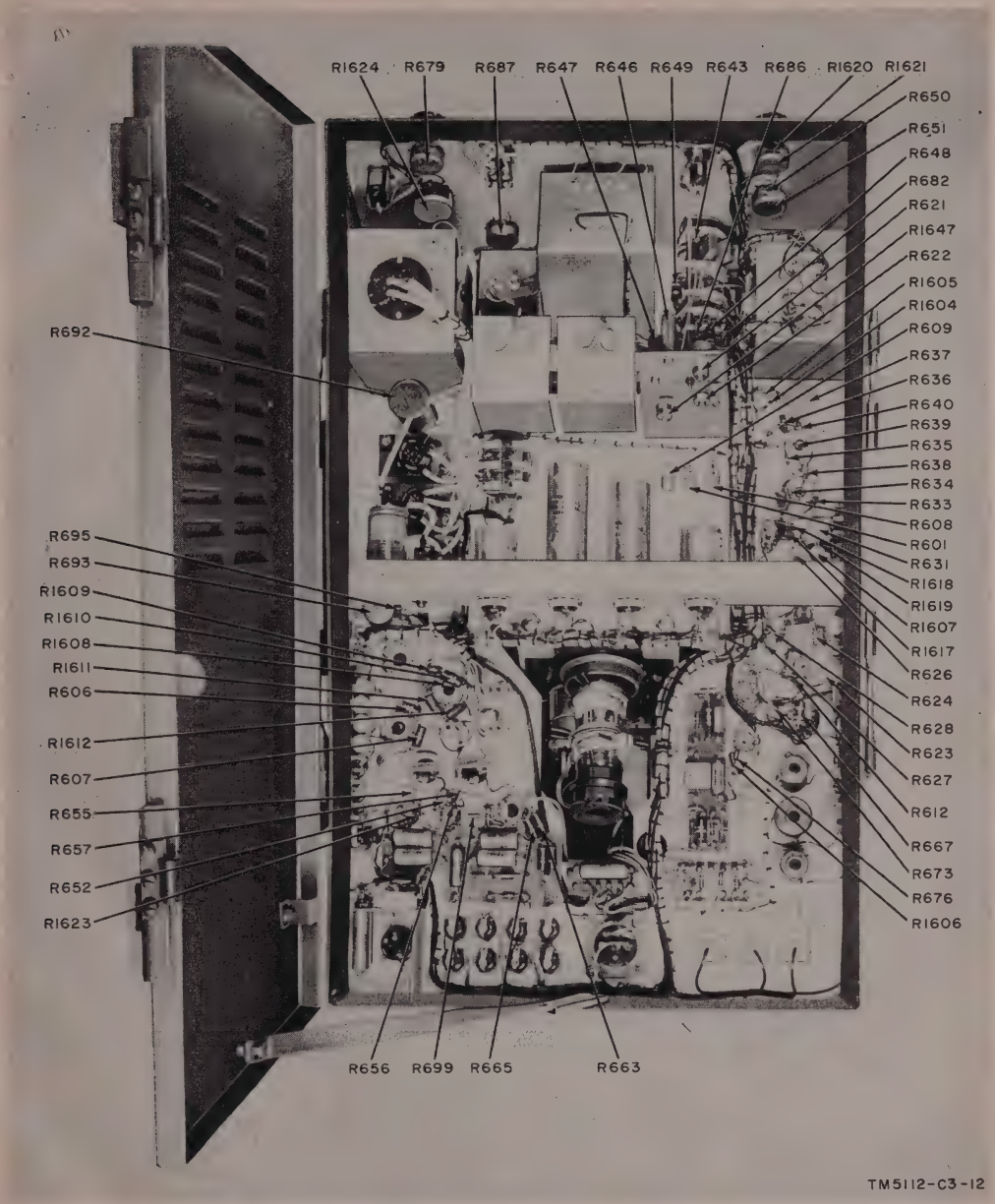


Figure 47.1. (Added) *Under-chassis view, Azimuth-Range Indicators IP–345A/TPS–1D and IP–406A/FPS–36, location of resistors.*

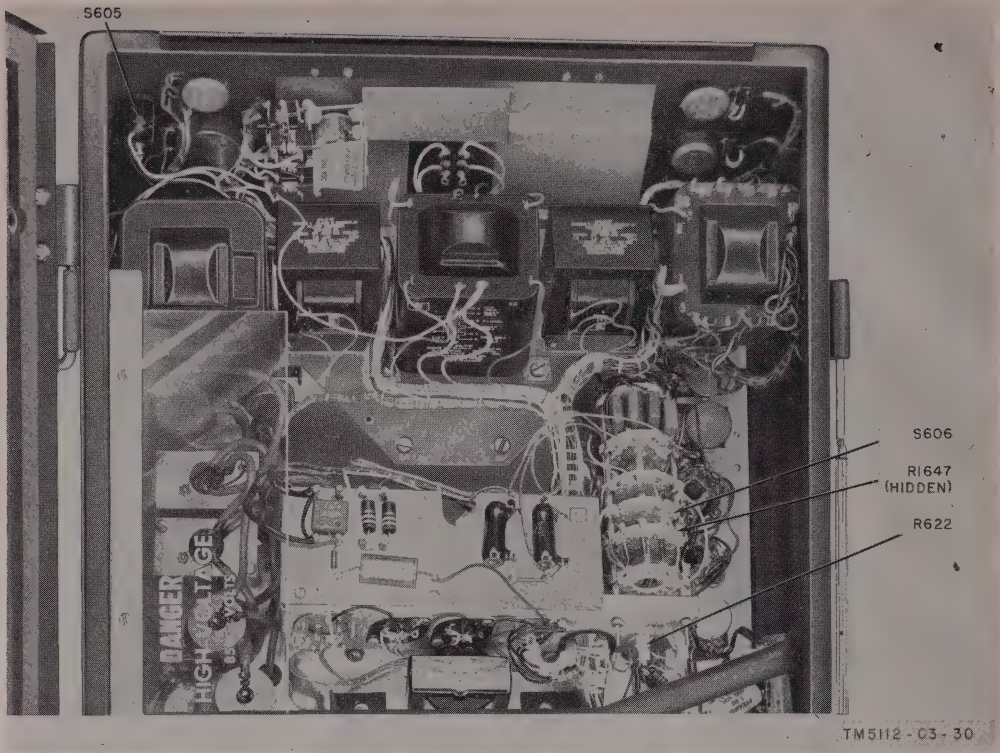


Figure 47.2 (Added) *Under-chassis view, Azimuth and Range Indicator IP–406/FPS–36, location of additional parts.*

Add subparagraph *d.1* after subparagraph *d:*

d.1. Figure 42.1, main chassis, Azimuth-Range Indicators IP–345A/TPS–1D and IP–406A/FPS–36, tube socket voltage and resistance diagram.

Add subparagraph *i.1.* after subparagraph *i:*

i.1. Figures 44.1, 45.1, 47.1, 49.1, 50.1, 51.1, 52.1, 53, 54, 55.1, and 56.1, location of detail parts in IP–345A/TPS–1D and IP–406A/FPS–36.

Page 63, figure 41. Add the following under "NOTES":

5. IN IP–345A/TPS–1D AND IP–406A/FPS–36, MARKERS ARE OBTAINED ON V620 PIN 3 INSTEAD OF PIN 8.

Pages 64 and 65, figure 42 (foldout). Under V609 and V611 change "6005/6AL5W" to **"6005/6AQ5W."**

Page 76, paragraph 72*a.* Make the following changes:

Change heading to: **Replacement of Azimuth Dial on IP–345/TPS–1D and IP–406/FPS–36 Only.**

Add the following after subparagraph *a:*

*a.*1. *Replacement of Azimuth Dial on IP–345A/TPS–1D and IP–406A/FPS–36 Only.* The inside of the cover is similar in appearance to that shown in figure 53, except that wire brackets MP633 and MP634 are interchanged, there is no hank of wire, and wire bracket A 651 is a short nylon clamp. Follow the procedure given in *a* above except omit steps in (2) and (8), because slack dial lamp wire is not tied into hank but is doubled back on itself. The dial lamp wire may be pulled through the tied loops for extension or retraction into the cover. See figures 18.1 and 2.1 for slight modification in cover removal procedure.

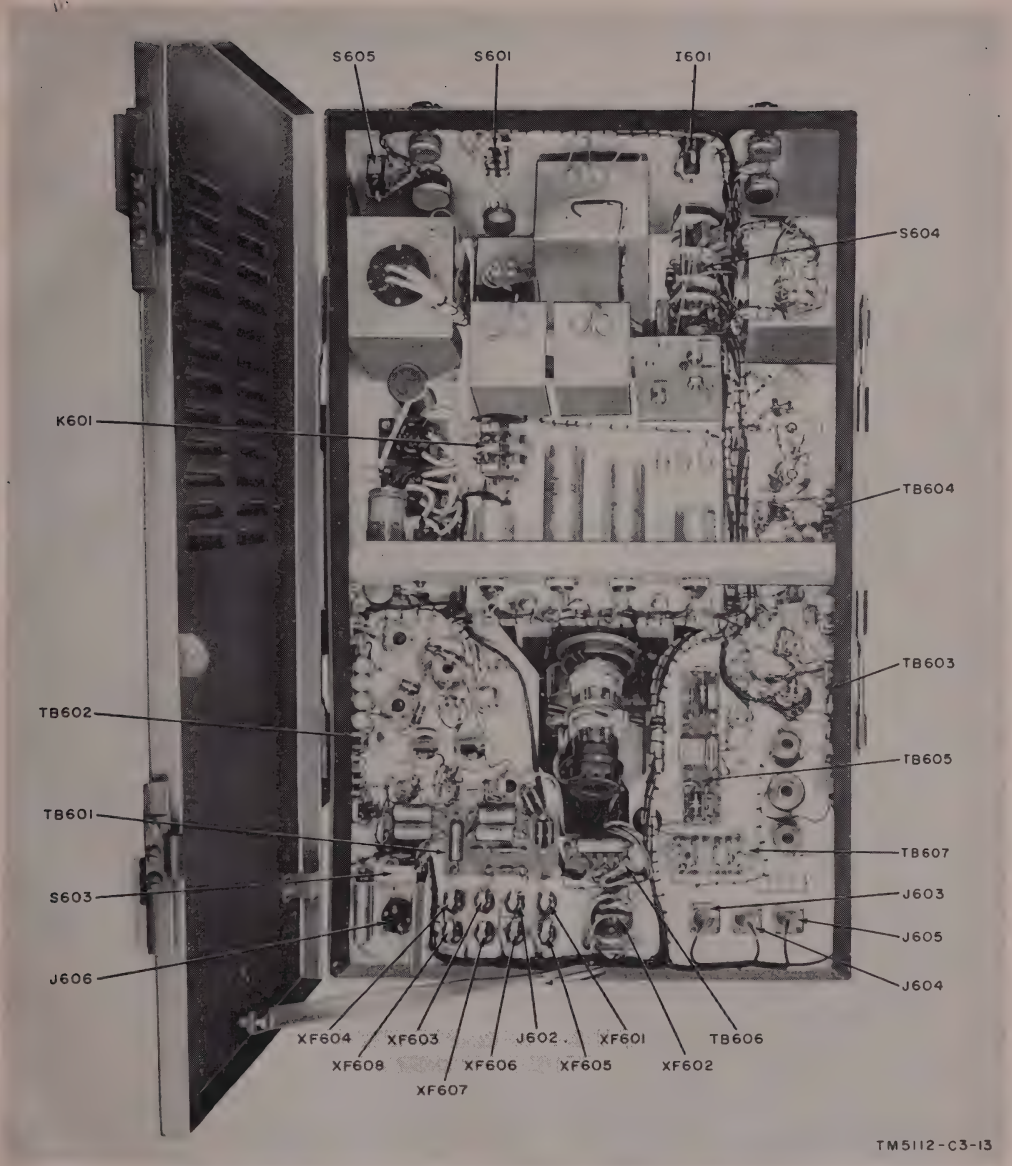


Figure 49.1. (Added) *Under-chassis view, Azimuth-Range Indicators IP–345A/TPS–1D and IP–406A/FPS–36, location of terminal boards and miscellaneous parts.*

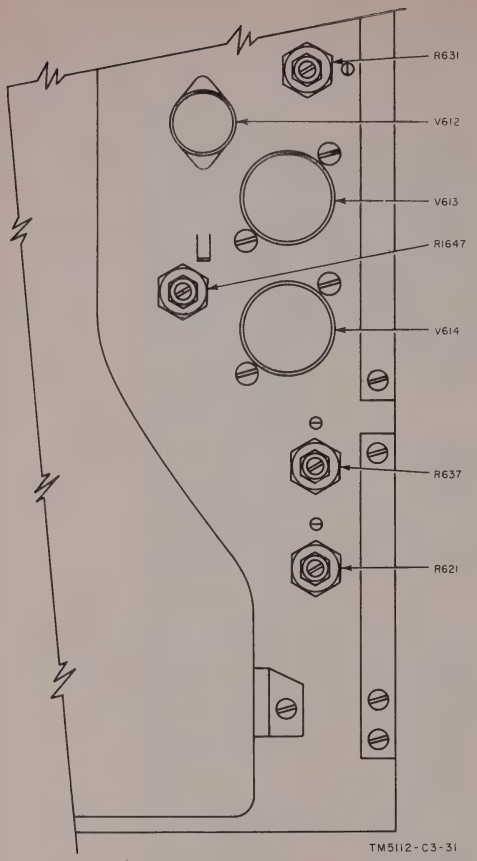


Figure 49.2. (Added) *Azimuth and Range Indicator IP–406/FPS–36, location of miscellaneous parts.*

Page 77, paragraph 72*b*. Make the following changes:

Change heading to: **Rotating Bezel Assembly on IP–345/TPS–1D and IP–406/FPS–36 Only.**

Add the following after subparagraph *b:*

b.1. *Rotating of Bezel Assembly on IP–345A/TPS–1D and IP–406A/FPS–36 Only.* The same mounting flexibility applies to the IP–345A/TPS–1D and IP–406A/FPS–36 as described for the IP–345/TPS–1D and IP–406/FPS–36 (*b* above). As delivered, the bezel is in position for table-top mounting. To change the position of the bezel for other than table-top mounting, proceed as follows:

(1) Remove cover A 621 (fig. 54 and *a*(1) above). (Also see figure 18.1.)
(2) Remove all screws (10) passing through the front of the cover. This will loosen the following for removal (fig. 53 and *a*.1. above): cursor control knob MP603, wire brackets MP633 and MP634, and cable clamp A 651. The entire bezel assembly will also be loosened for rotation but not for removal.
(3) Cut lacing cord binding doubled portion of the dial and cursor lamp cable.
(4) Rotate the entire bezel assembly 180° in a clockwise direction to point where holes again line up.
(5) Fasten cursor control knob in place opposite its original position by using the two 4–40 by ½ inch screws ((2) above). Be sure lockwashers are reinstalled.
(6) Secure bezel assembly in place; use five screws and locknuts through the rim of bezel bottom MP604. With the installation of this hardware, loosely secure wire brackets MP633 and MP634 in position diametrically opposite their original positions.
(7) Place the dial lamp wire under wire bracket MP634 and tighten the screw and nut.
(8) Place the cursor lamp (movable lamp) wires under wire bracket MP633 and tighten the screw and nut.
(9) Secure cursor lamp wires through cable clamp A 651 mounted in position diametrically opposite its original position.
(10) Close hole at original position of cable clamp A 651 with a screw and locknut.
(11) Close hole at original position of cursor control knob with a screw and locknut.
(12) Use lacing cord to tie the three wires into a cable to a point about ½ inch beyond wire bracket MP633.

Page 78, paragraph 72*d*. Make the following changes:

Change heading to: **Removal of Cathode-ray Tube on IP–345/TPS–1D and IP–406/FPS–36 Only** (figs. 55 and 56).

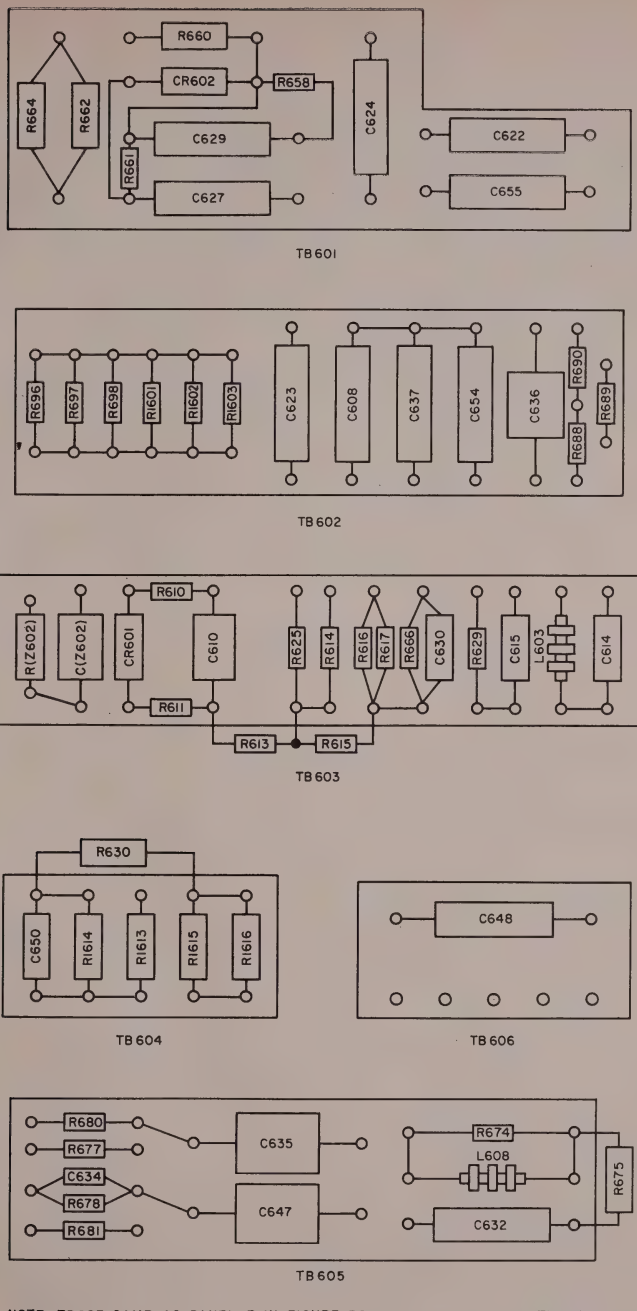


Figure 50.1. (Added) *Terminal boards on Azimuth-Range Indicators IP–345A/TPS–1D and IP–406A/FPS–36.*

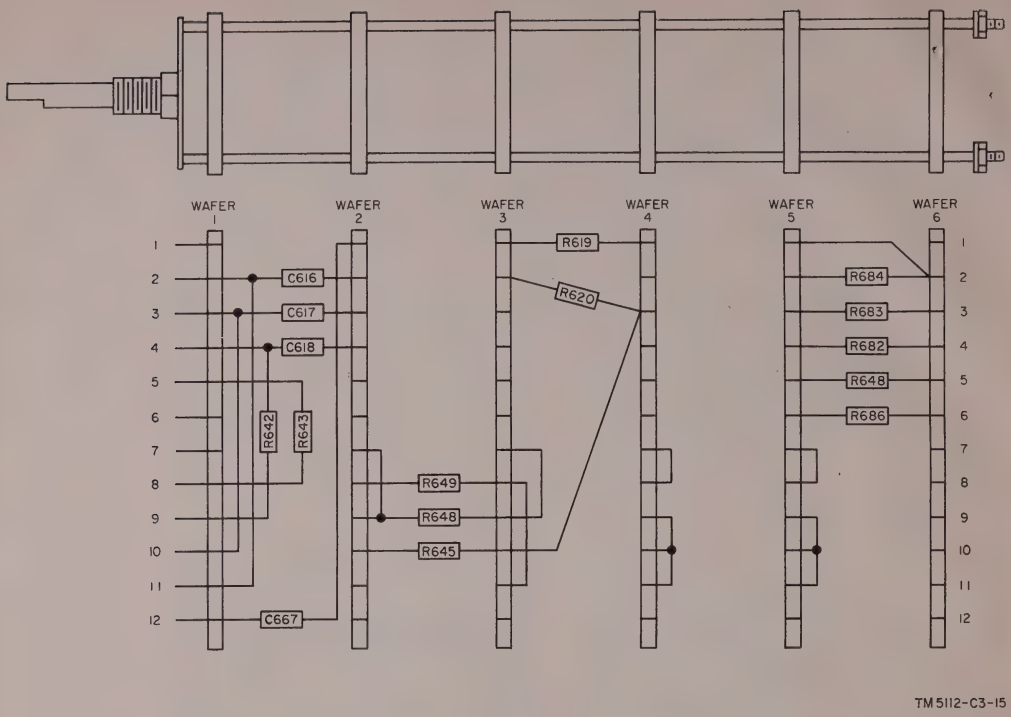


Figure 51.1. (Added) *Range switch connections on Azimuth-Range Indicators IP–345A/TPS–1D and IP–406A/FPS–36.*

Add the following after the heading:

Warning: **Protective gloves and eye shields should be worn whenever a crt is removed and/or installed. Turn off power and discharge all capacitors with a shorting bar before doing any work around a crt.**

Add the following after subparagraph *d:*

*d.*1. *Removal of Cathode-ray Tube on IP–345A/TPS–1D and 1P–406A/FPS–36 Only* (figs. 55.1 and 56.1).

(1) Remove the cover (*a*(1) above and fig. 18.1) and disconnect the high-voltage anode lead connected to the crt (fig. 56.1).

(2) Open the indicator chassis to the servicing position (fig. 4.1).

(3) Carefully remove tube socket XV621 from the base of the crt.

(4) Loosen the focusing magnet clamping screw (fig. 55.1) and remove the focusing magnet from the neck of the crt.

(5) Loosen the centering magnet clamping screw and remove the centering magnet from the neck of the crt.

(6) Close the indicator to the operate position.

(7) Using a $\frac{7}{16}$-inch hexagonal socket wrench, loosen the locknut on the shield-securing hook bolt (fig. 56.1) enough to unhook and slide back.

(8) Use the wrench ((7) above), to remove the shield-securing bolts on both sides under the crt face.

(9) Carefully support the crt and remove the front half of the crt shield. Do not strike the shields sharply in any way because this may impair their magnetic shielding properties.

(10) Draw the crt toward the front and lift it out of the chassis.

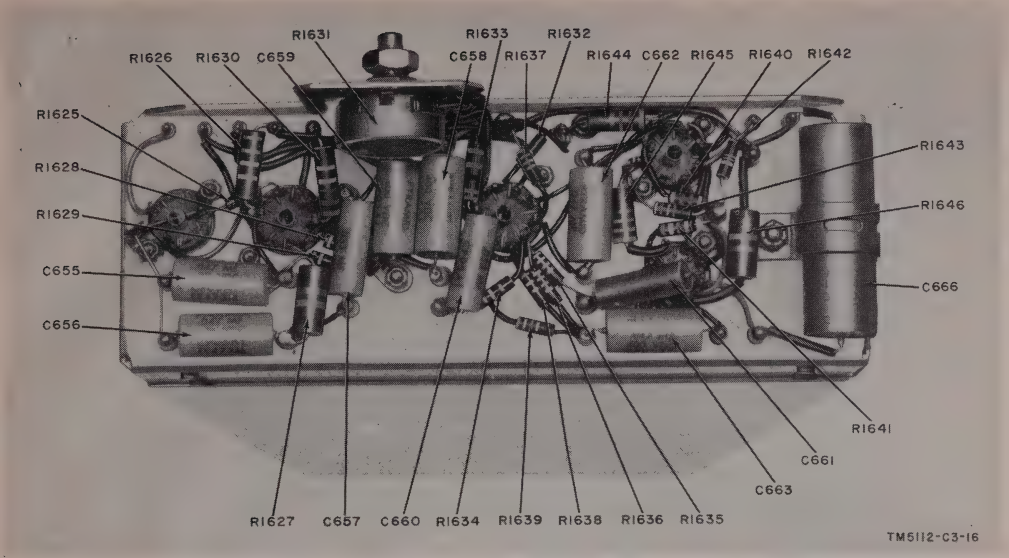


Figure 52.1. (Added) *Servo amplifier chassis on Azimuth-Range Indicators IP–345A/TPS–1D and IP–406A/FPS–36, location of parts.*

Page 80, paragraph 72*e*. Make the following changes:

Change heading to: **Installation of Cathode-Ray Tube in IP–345/TPS–1D and IP–406/FPS–36 Only.**

Add the following after subparagraph *e:*

f. Installation of Cathode-Ray Tube in the IP–345A/TPS–1D and IP–406A/FPS–36 Only.

(1) Place the crt in the chassis with its neck passing through deflection coil assembly L609, and the high-voltage anode accessible through the hole in the rear half crt shield.

(2) Hold the crt and place the front half of the crt shield over the rim of the crt face; tighten the shield-securing bolts with a $\frac{7}{16}$-inch hexagonal socket wrench on both sides under the crt face until the rubber bumpers just touch the crt rim.

(3) Install the shield-securing hook bolt and tighten moderately until the eight rubber bumpers just touch the crt rim. These bumpers are visible between the crt face and the front half shield opening. Turn the deflection coil assembly by hand as the tube is installed to see that the crt neck does not touch it at any time. A binding or scraping noise indicates that the crt must be reseated ((1) and (2) above and this subparagraph).

(4) Tighten the two shield-securing bolts and the hook bolt nut $1\frac{1}{2}$ turns. Tighten all three shield-securing bolts evenly.

(5) Connect the high-voltage anode lead to the crt.

(6) Open the chassis to the servicing position (fig. 4.1).

(7) Slide the centering magnet onto the neck of the crt with the magnet rings on the side away from the crt base. At about $\frac{1}{4}$ inch from the deflection coil assembly, tighten the clamping screw just enough to allow adjustment.

(8) Slide the focusing magnet onto the neck of the crt with the magnet rings on the side away from the crt base. Leave about $\frac{1}{2}$ inch between the centering magnet and focusing magnet and tighten the clamping screw just enough to allow adjustment.

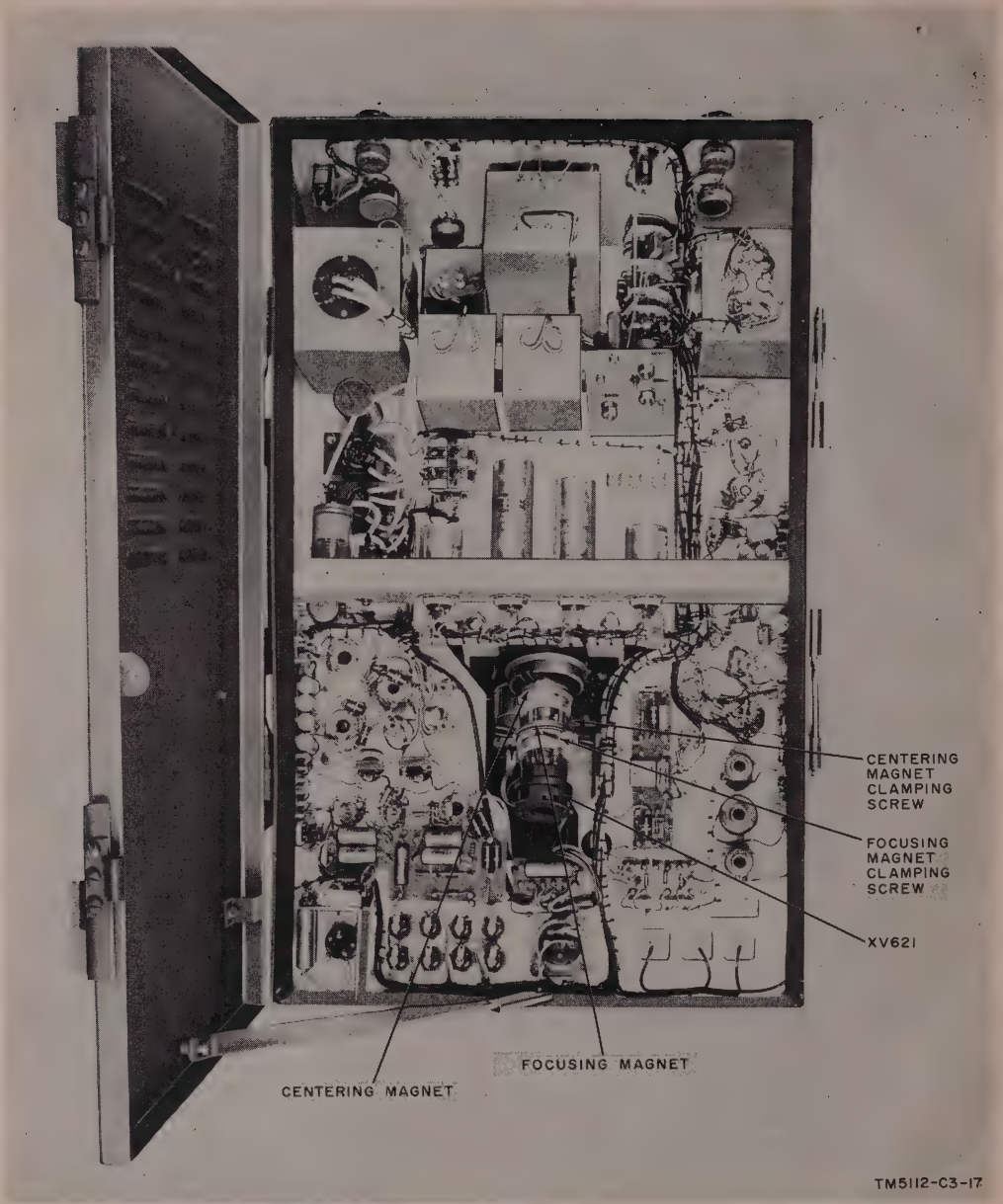


Figure 55.1. (Added) *Bottom chassis view, Azimuth-Range Indicators IP–345A/TPS–1D and IP–406A/FPS–36, replacement of crt.*

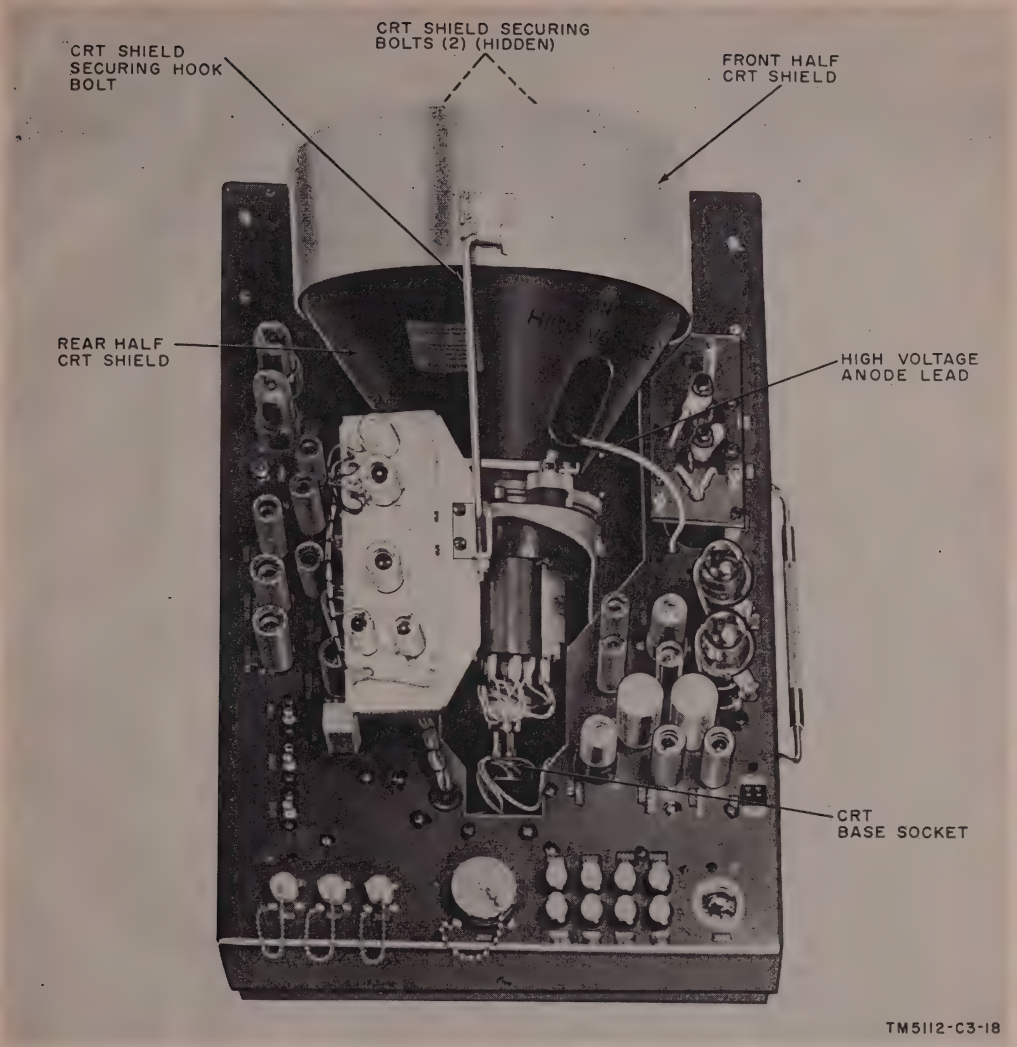


Figure 56.1. (Added) *Top chassis view, Azimuth-Range Indicators IP–345A/TPS–1D and IP–406A/FPS–36, replacement of crt.*

(9) Connect tube socket XB621 to the crt base.

(10) Perform the mechanical focusing and centering alignment given in paragraph 17, as applicable to the IP–345A/TPS–1D.

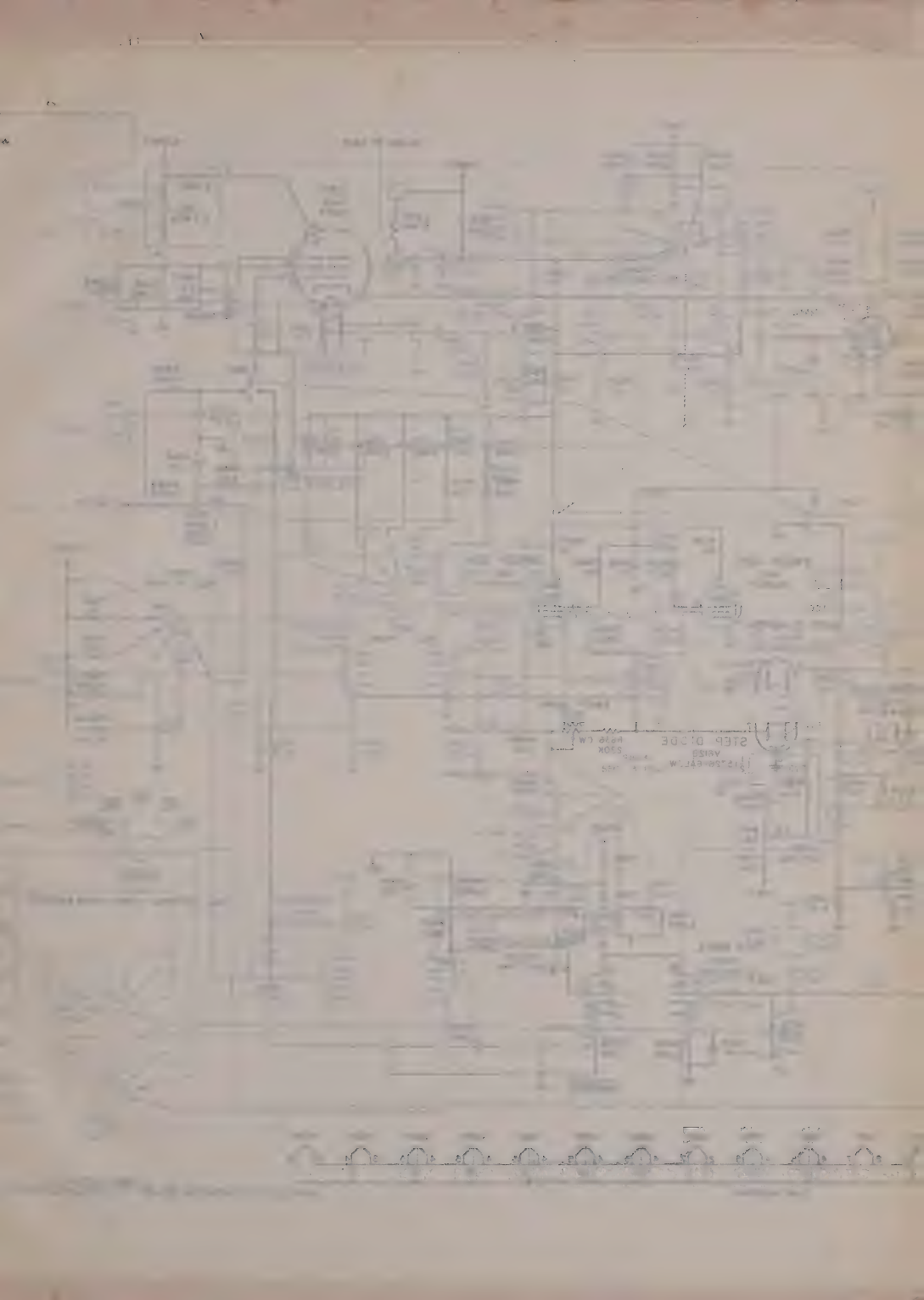
Page 48, paragraph 77*a*. Add subparagraph (1.1) after subparagraph (1):

(1.1) The IP–345A/TPS–1D and IP–406A/FPS–36 will have the rear half crt shield remaining in place after removal of the cathode-ray tube. Remove this by unscrewing the four 8–32 by 1¾-inch binding head machine screws that pass through the 1$\frac{1}{16}$-inch spacers at the four corners of the plate

that supports the rear half crt shield. Take particular note of the spacer in the upper left-hand corner. Remove the plate and rear half shield.

Page 85, paragraph 77*b*. Add subparagraph (14.1) after subparagraph (14) :

(14.1) If this work is being done on the IP–345A/TPS–1D or the IP–406A/FPS–36, the rear half crt shield must be reinstalled by fastening it in place with the four spacers and 8–32 by 1¾-inch screws removed in step *a* (1.1) above. Reinstall all lockwashers. Be sure that the flatted spacer is returned to the upper left hand corner. Use a suitable shim between this spacer and spur gear MP649 when tightening the screw so that clearance is assured between them.



that supports the rear half crt shield. Take particular note of the spacer in the upper left-hand corner. Remove the plate and rear half shield.

Page 85, paragraph 77*b*. Add subparagraph (14.1) after subparagraph (14) :

(14.1) If this work is being done on the IP–345A/TPS–1D or the IP–406A/FPS–36, the rear half crt shield must be reinstalled by fastening it in place with the four spacers and 8–32 by 1¾-inch screws removed in step *a* (1.1) above. Reinstall all lockwashers. Be sure that the flatted spacer is returned to the upper left hand corner. Use a suitable shim between this spacer and spur gear MP649 when tightening the screw so that clearance is assured between them.

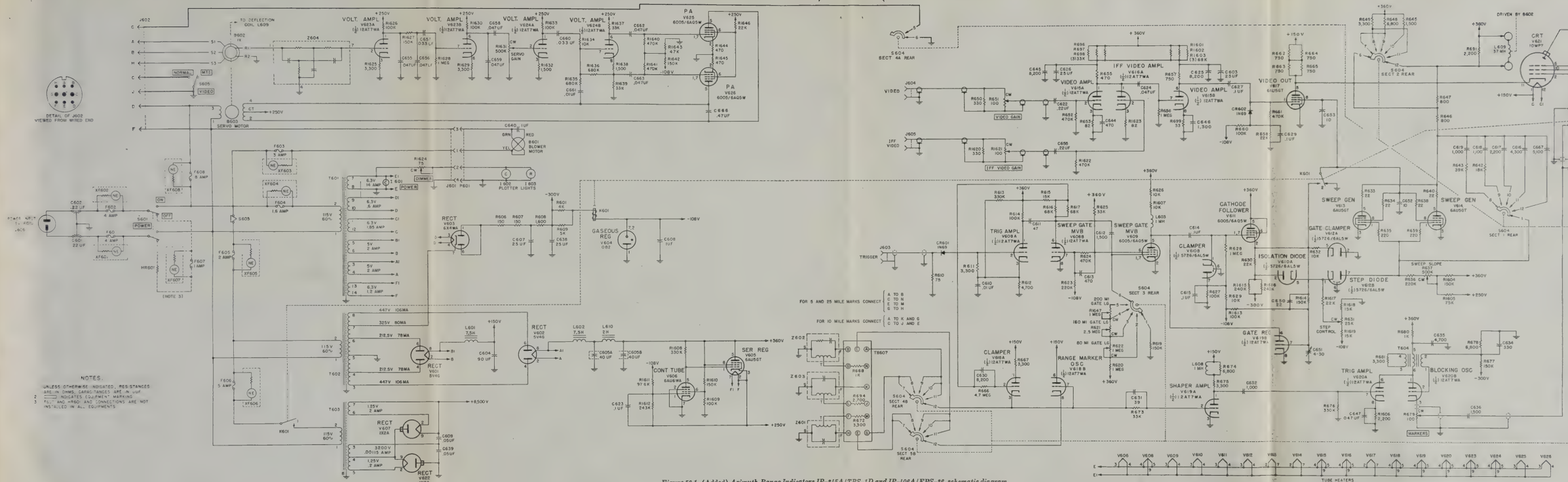


Figure 59.1. (Added) *Azimuth-Range Indicators IP-345A/TPS-1D and IP-406A/FPS-36, schematic diagram.*

+360V
R649 3,300
R648 6,800
R645 1,500
S606 SECT 2 REAR
DRIVEN BY B602
+360V
R691 2,200
L609 37 MH
CRT V621 10WP7
+8,500V
1.5 MEG
(15) 2.7 MEG
R692
R693 2.5 MEG
R695 10 MEG
C648 .1UF
FOCUS
+150V
C
C1
R647 800
R646 800
DETAIL VIEWED FRO
K601
R690 15 MEG
C637 .1UF
C654 .1UF
R689 22K
R688 330K
CW
-300V
R687 100K
INT
C619 1,000
C618 1,100
C617 2,200
C616 4,300
C667 5,100
R643 39K
R642 18K
R633 22
R640 22
R634 22
C652 .10
R638 22
SWEEP GEN V614 6AU5GT
R635 220
R639 220
S606 SECT 1 REAR
R686 51K
S606 SECT 5A REAR
R684 1K
R683 1,500
R682 3,600
R1648 4,300
+150V
POWER INPUT 115V 60~ J606
SWEEP SLOPE
R637 500K
R636 CW 220K
R1604 150K
+360V
R1605 75K
+250V
STEP DIODE V612B (1/2) 5726/6AL5W
+360V
R680 1K
C635 4,700
T604
R678 6,800
C634 330
R681 3,300
R677 150K
BLOCKING OSC V620B (1/2) 12AT7WA
-300V
G AMPL V620A (1/2) 12AT7WA
C647 .01UF
R1606 2,200
C636 1,500
R679 100
CW
MARKERS
40
80
160
20
200
RANGE
S606
(ALL SECTIONS VIEWED FROM KNOB)
V617
V618
V619
V620
V623
V624
V625
V626
1. UNLESS ARE IN
2. IN
3. F607 AND INSTALLE
4. HEAVY LIN AZIMUTH

TM5112-C3-34

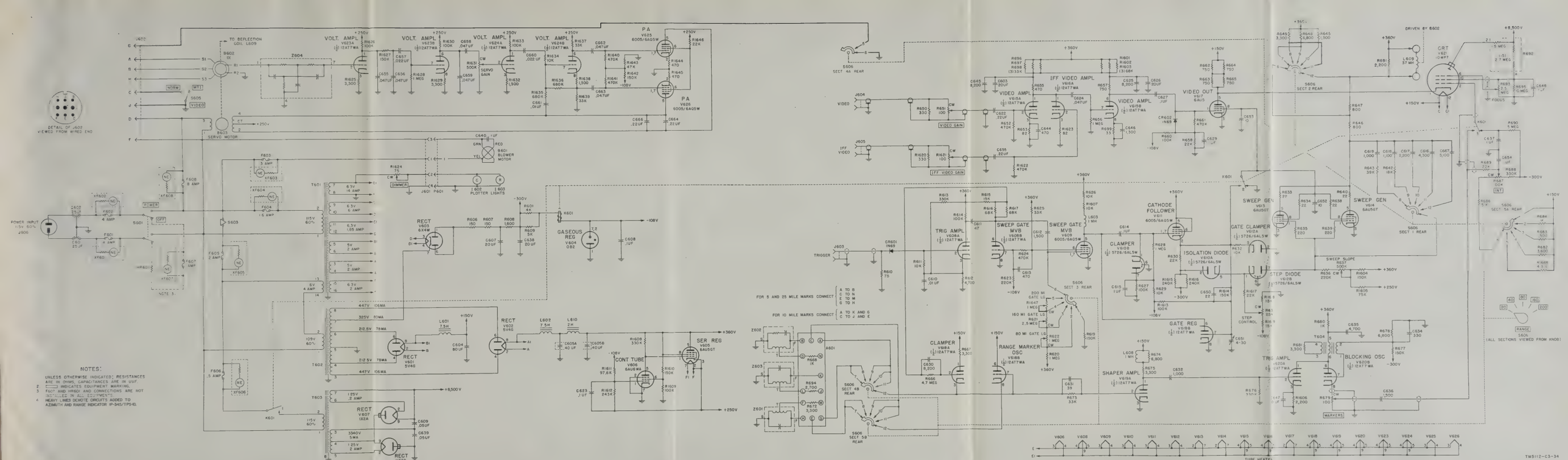


Figure 59-2. (Added) *Azimuth and Range Indicator IP-406/FPS-16, schematic diagram.*

[AG 413.682 (30 Sep 58)]

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Army Terminals (1)
OS Sup Agcy (2)
Yuma Test Sta (2)
USA Elct PG (1)
Sig Lab (5)
Sig Fld Maint Shops (3)
Fld Comd, AFSWP (5)
Mil Dist (1)
Sector Comd, US Army Corps (Res) (1)
US Army Corps (Res) (1)
JBUSMC (2)
Units org under fol TOE:
  6–200 (2)
  11–7 (2)
  11–16 (2)
  11–57 (2)
  11–127 (2)
  11–128 (2)
  11–500 (AA–AE) (2)
  11–557 (2)
  11–587 (2)
  11–592 (2)
  11–597 (2)
  44–7 (2)
  44–17 (2)
  44–35 (2)
  44–36 (2)
  44–37 (2)
  44–115 (2)
  44–116 (2)
  44–145 (2)
  44–146 (2)
  44–275 (2)
  44–276 (2)
  44–277 (2)
  44–445 (2)
  44–446 (2)
  44–545 (2)
  44–546 (2)

NG: State AG (6); units—same as Active Army except allowance is one copy to each unit.

USAR: None.

For explanation of abbreviations used, see AR 320–50.

☆ U. S. GOVERNMENT PRINTING OFFICE: 1958—480504

TECHNICAL MANUAL

AZIMUTH AND RANGE INDICATOR IT-345/TPS-1D, FIELD MAINTENANCE

TM 11-5112
Changes No. 1

DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *5 March 1956*

TM 11-5112, 20 January 1956, is changed as follows:

Paragraph 14*b*(6). Line 1. Change "P418" to read: **P417.**

Paragraph 17.

e. (Superseded) *For 80-mile and 160-mile Gate Length Adjustments.* With a trigger input supplied from the master radar and the remote ppi energized, proceed as follows:

(1) Place the RANGE switch in the 80 position and display 10-mile markers.

(2) Adjust 80-mile gate length control R622 (fig. 47) so that the sweep ends just beyond the 80-mile marker.

Note. Always adjust the 80-mile gate length control first to prevent interaction with the 160-mile gate length control.

(3) Place the RANGE switch in the 160 position and turn up the MARKERS control (if necessary) to display the range markers.

(4) Adjust 160-mile gate length control R621 (fig. 13) so that the sweep ends just beyond the 160-mile marker.

Paragraph 49*b*. Add this sentence between the tenth and eleventh sentences: Resistor R622 is the 80-mile gate length control.

Paragraph 55. Add the following to subparagraph *c*. A wire is connected from the decoupling network in the plate circuit of V615A and V616A to the decoupling network of V615B. The purpose of this strapping is to cancel out any transients not canceled by the decoupling networks. These transients cause the crt to brighten when RANGE switch S604 is changed from one position to another. The transients in these circuits will be 180° out of phase and will cancel.

Figure 25. Change fixed resister R622 to a **potentiometer.** Use R621 as a sample. Connect the arm of the potentiometer to the junction of R622 and R620. Delete the value "680K" and substitute 1 MEG. Add 80 MILE GATE LENGTH to the left of R622.

Figure 27. Change the value of R691 from "15K" to **2,200.**

Figure 28. Change the value of R666 from "2.2 MEG" to **4.7 MEG.**

Figure 30. Draw a line from the junction of R655 and C603 (in the plate circuit of V615A and V616A) toward the right side of the diagram. Terminate the line in an arrowhead. Label the arrowhead: TO THE JUNCTION OF R657 AND C625.

Figure 31. Draw a line from the junction of R657 and C625 (in the plate circuit of V615B) toward the left of the diagram. Terminate the line in an arrowhead. Label the arrowhead: TO THE JUNCTION OF R655 AND C603.

Figure 47. Add potentiometer R622 to this illustration. The specific location is within the mounting hole on the metal bracket found at the left-hand side of potentiometer R631 and above tube socket XV611 (fig. 45). Draw an arrow to R622 and label the callout R622.

Figure 51. Delete R622.

Figure 59. Draw a line between the junction of R655 and C603 (in the plate circuit of V615A and V616A) to the junction of R657 and C625 (in the plate circuit of V615B).

Figure 59(2). Change R666 from "2.2 MEG" to **4.7 MEG.** Change R691 from "15K" to **2,200.** Change R622 to a **potentiometer.** Use R621 as a sample. Add "CW" at the junction of R622 and R620. Add "80 MI GATE LENGTH" at the left-hand side of R622. Add "160 MI" above GATE LENGTH to the left of R621.

Figure 60. In the area VERTICAL C and HORIZONTAL 6, connect a wire between the right end of R655 and the right end of R657.

Figure 60(1). Delete R622. It is found in the area VERTICAL 14 and HORIZONTAL G. Add the new potentiometer R622 in the vacant area VERTICAL 14 and HORIZONTAL H. Use the

potentiometer R621 (located VERTICAL 16 and HORIZONTAL E) as a sample. Label the potentiometer R622 CW, ARM and CCW as per sample. Connect CW to the ARM. Connect the CW end to 3 of S604(3) and connect the CCW end to 4 of S604(3).

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	11–587R (2)	
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USAR: None.
For explanation of abbreviations used, see SR 320–50–1.

U. S. GOVERNMENT PRINTING OFFICE: 1956

AZIMUTH AND RANGE INDICATOR IP-345/TPS-1D

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Figure 1. Azimuth and Range Indicator IP-345/TPS-1D.

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1. Scope

a. This manual contains instructions for the installation, operation, maintenance, and repair of Azimuth and Range Indicator IP-345/TPS-1D (fig. 1).

b. Forward comments on this publication directly to Commanding Officer, The Signal Corps Publications Agency, Fort Monmouth, New Jersey.

2. Forms and Records

a. Unsatisfactory Equipment Report. DA Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer as prescribed in SR 700-45-5.

b. Damaged or Improper Shipment. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745-45-5 (Army).

c. Preventive Maintenance Forms.

(1) DA Form 11-238, Operator First Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar), will be prepared in accordance with instructions on the back of the form (fig. 19).

(2) DA Form 11-239, Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar), will be prepared in accordance with instructions on the back of the form (fig. 20).

Section II. DESCRIPTION AND DATA

3. Purpose and Use

a. Azimuth and Range Indicator IP-345/TPS-1D (fig. 1) is a remote plan position indicator (ppi) unit for use with Radio Set AN/TPS-1D. Its purpose is to repeat, at a remote point, target and identification friend or foe (iff) information appearing at the radar set.

Note. Throughout this manual, the radar set which supplies the target and iff information to the remote ppi is referred to as the master radar set.

b. The remote ppi is a self-contained unit that operates from synchronous servo, trigger, and video data supplied by Radio Set AN/TPS-1D. The equipment is intended for field station operation in a building, shelter, or stationary vehicle within 150 feet of the radar set.

c. Azimuth and Range Indicator IP-345/TPS-1D can also be used with any master radar set that supplies trigger and video signals with the required characteristics (par. 4).

4. Technical Characteristics

Display tube ..... Electrostatic-focus, magnetic-deflection, 10-inch cathode-ray tube type 10WP7.

Available sweep ranges ..... 20, 40, 80, and 160 nautical miles.

Range determination ..... Ten nautical mile markers at all ranges or 10,000-yard markers with the 20- and 40-mile sweep lengths and 50,000-yard markers at the 80- and 160-mile sweeps.

Bearing determination ..... A reflection-plotter and cursor with two straight lines intersecting at right angles at the tube center and an amber-colored ring with etched degree marks.

Trigger input:

- Polarity ..... Positive.
- Repetition rate ..... Not less than 57 nor more than 2,000 pps.
- Duration ..... Not less than .2 microsecond nor more than 10 microseconds as measured at 85% of nominal peak voltage.
- Nominal peak voltage ..... Not less than 5 volts nor more than 50 volts, measured across 75 ohms.
- Rise time ..... Within 20% of pulse length. Rate of rise never should be less than 25 volts per microsecond.
- Maximum overshoot ..... Not greater than 10% of nominal peak voltage.

Video input ..... Positive, 1 to 2.5 volts peak measured across 75 ohms. Separate input for radar and iff video.

Number of tubes ..... 26.

Accuracy:

- Tracking accuracy ..... 1° with respect to data of master radar.

Range marks accuracy ..... +1% of indicated range.

Power requirements ..... 115 (+5%) volts ac, 60 (+4%) cycles, single-phase, 160-watt input.

Weight of indicator in cabinet ..... 93 lb.

5. Packaging Data

When packed for shipment, the components of Azimuth and Range Indicator IP-345/TPS-1D are placed in moisture- vaporproof containers and packed in a wooden crate. Typical packaging is illustrated in figure 5. The size, weight, and volume of the crate are indicated in the following chart:

Case No.	*Height (in.)*	*Width (in.)*	*Depth (in.)*	*Volume (cu ft)*	*Total weight (lb)*	*Contents*
1	21	23	36	10	143	Items listed in paragraph 6 plus running spares

6. Table of Components (fig. 2)

Components	Req No.	Height (in.)	Depth (in.)	Length (in.)	Volume (cu ft)	Unit wt (lb)
Azimuth and Range Indicator IP-345/TPS-1D including:	1	17¾	28	17¼	5	93
Cord CG-247C/U (25 ft-o in) (W1, W2, and W3)	3	.3		300ea	.12	2.12
Electrical power cable assembly CX-3704/U (15 ft-0 in) (W5)	1	.3		180	.065	1
Electrical power cable assembly CX-3705/U (25 ft-0 in) (W4)	1	.5		300	.034	3.5
Azimuth ring graduated at 50-mil intervals	1	.25		9.8	.014	2
Technical Manual TM 11-5112	2	10¼		7⅞		1
Viewing hood for 10 in. ppi	1	11.5	10.5	10.5	.28	1

Note. This list is for general information only. See appropriate supply publications for information pertaining to requisition of spare parts. Refer to paragraph 10 for a list of additional equipment required but not supplied.

7. Common Name Versus Nomenclature

A list of the nomenclature assignments for the components of Azimuth and Range Indicator IP-345/TPS-1D is given below. A common usage name is indicated for each component.

Nomenclature	*Common name*
Azimuth and Range Indicator IP-345/TPS-1D	Remote ppi
Cord CG-247C/U (25 ft-0 in)	Trigger cable W1
Cord CG-247C/U (25 ft-0 in)	Video cable W2
Cord CG-247C/U (25 ft-0 in)	Iff cable W3
Electrical Power Cable Assembly CX-3705/U (25 ft-0 in)	Synchro cable W4
Electrical Power Cable Assembly CX-3704/U (15 ft-0 in)	Power cable W5

8. Description of Azimuth and Range Indicator IP-345/TPS-1D

a. Azimuth and Range Indicator IP-345/TPS-1D is a compact remote ppi for installation remote from the master radar equipment. This unit can be mounted on a table or shelf, on a vertical wall, or on the ceiling or other overhead structure. To permit this variety of mounting positions, the name plates and marker plates are engraved on both the front and back and are reversible.

b. All subassemblies and detail parts of the remote ppi are mounted on a chassis and case assembly. The chassis and case assembly has a removable cover that contains a blower and an illuminated cursor and reflection plotter (fig. 3).

c. All necessary operating controls are mounted at the sloping front of this chassis and case assembly. Connection jacks for the external cables and the fuses and blown fuse indicators are grouped at the rear of the unit.

d. The chassis and case assembly is secured to a combination mounting base and bottom cover with two pairs of hinge pins. These hinge pins are extensions of the carrying handles (fig. 4). Both pairs of hinge pins may be released to completely separate the chassis and case assembly from the base plate. For convenience in servicing, either one of the two hinge devices can be released and the unit opened by pivoting the chassis and case assembly on the other hinge. A latch is provided to secure the chassis and case in the open (90°) position (fig. 4).

9. Description of Minor Components (fig. 2)

a. Viewing Hood. A cone-shaped viewing hood of black vinyl plastisol compound is provided for snapping over the window rim of the

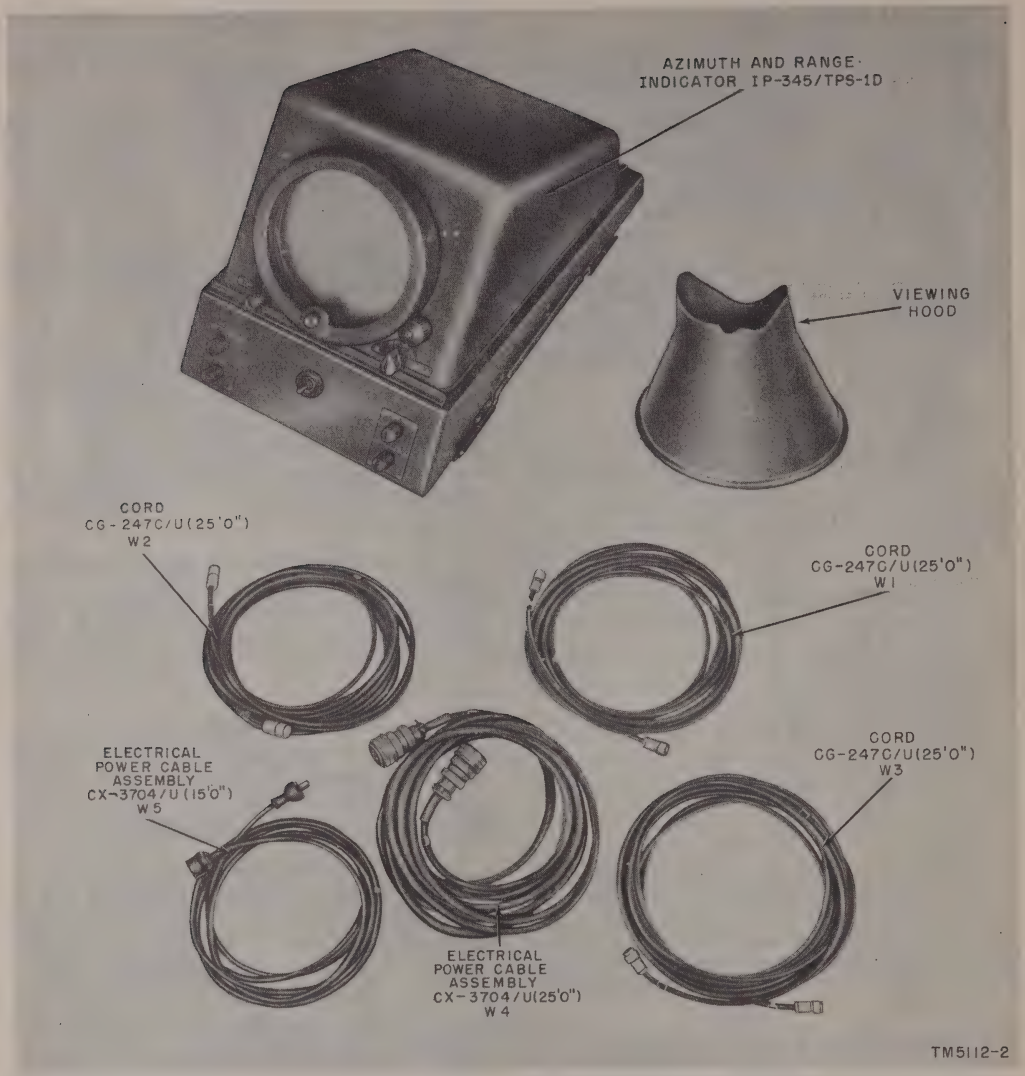


Figure 2. Azimuth and Range Indicator IP-345/TPS-1D, operating components.

cathode-ray tube (crt) to exclude excessive surrounding light from the face of the crt. It is 11½ inches high with a base diameter of 10½ inches. The viewing end of the hood is a modified cone 5⅝ inches long and 3 inches wide and is shaped to fit snugly the facial contour of the eyes and forehead.

b. Cord CG-247C/U (25 ft-0 in). Trigger cable W1, video cable W2, and iff cable W3 are all 76-ohm coaxial cables. These cables have a polyethylene dielectric with Connector UG-18C/U on each end. The trigger cable is marked with the symbol designations W1, P603, and P414. The video cable is marked W2, P604, and P419. The iff cable is marked W3, P605, and P418. All three cables are connected from the

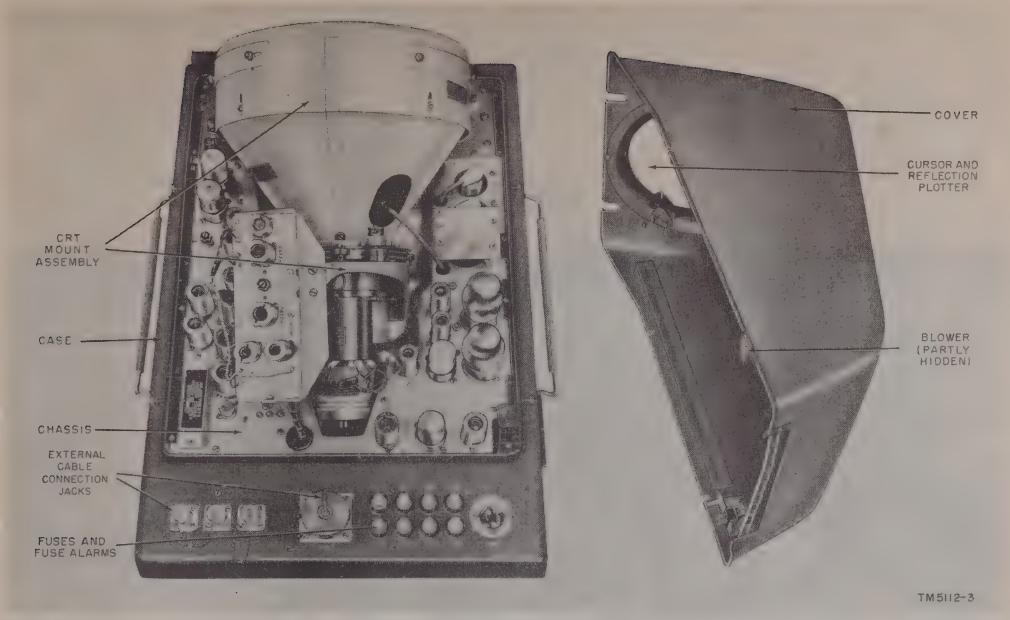


Figure 3. Azimuth and Range Indicator IP-345/TPS-1D, cover removed.

rear of the remote ppi to Power Supply PP-674/TPS-1D. (fig. 8).

c. Electrical Power Cable Assembly CX-3705/U (25 ft-0 in). Synchro cable W4 is a five-conductor cable made of synthetic or natural rubber. This cable has a connector AN 3106A-28-1P on each end. The maximum rated voltage of the conductors is 600 volts root mean square (rms). Synchro cable W4 is marked W4, P602, and P412.

d. Electrical Power Cable Assembly CX-3704/U (15 ft-0 in). Power cable W5 is a two-conductor cable with Connector U-120/U on one end and a Harvey Hubbell Inc. type 7464 plug on the other. The maximum voltage rating of the conductors is 600 volts rms. Power cable W5 is marked W5, P1, and P606.

e. Azimuth Dial. The azimuth dial is a glass disk upon which is etched an amber-colored ring graduated in 50-mil intervals with markings at 100-mil intervals. It can be used instead of the azimuth dial marked in degrees that is furnished with the equipment. Instructions for the removal and replacement of the azimuth dials are given in paragraph 72.

10. Running Spares

The following is a list of running spares supplied with Azimuth and Range Indicator IP-345/TPS-1D.

Quantity	*Description*
1	tube type 6AU6WA
1	tube type OB2
1	tube type 1X2A
1	tube type 5V4G
2	tube type 6AU5G
1	tube type 6X4W
3	tube type 12AT7WA
1	tube type 10WP7
1	tube type 5726/6AL5W
2	tube type 6006/6AQ5W
10	fuses, 4 amp, Bussman MDX, 125v
5	fuses .3 amp, Bussman MDL, 250v
5	fuses, 1.6 amp, Bussman MDL, 125v
5	fuses, 1.25 amp, Bussman MDL, 250v
5	fuses, 2 amp, Bussman MDL, 125v
5	fuses .5 amp, Bussman MDL, 250v

Note. This list is for general information only. See appropriate supply publications for information pertaining to allowable spare parts.

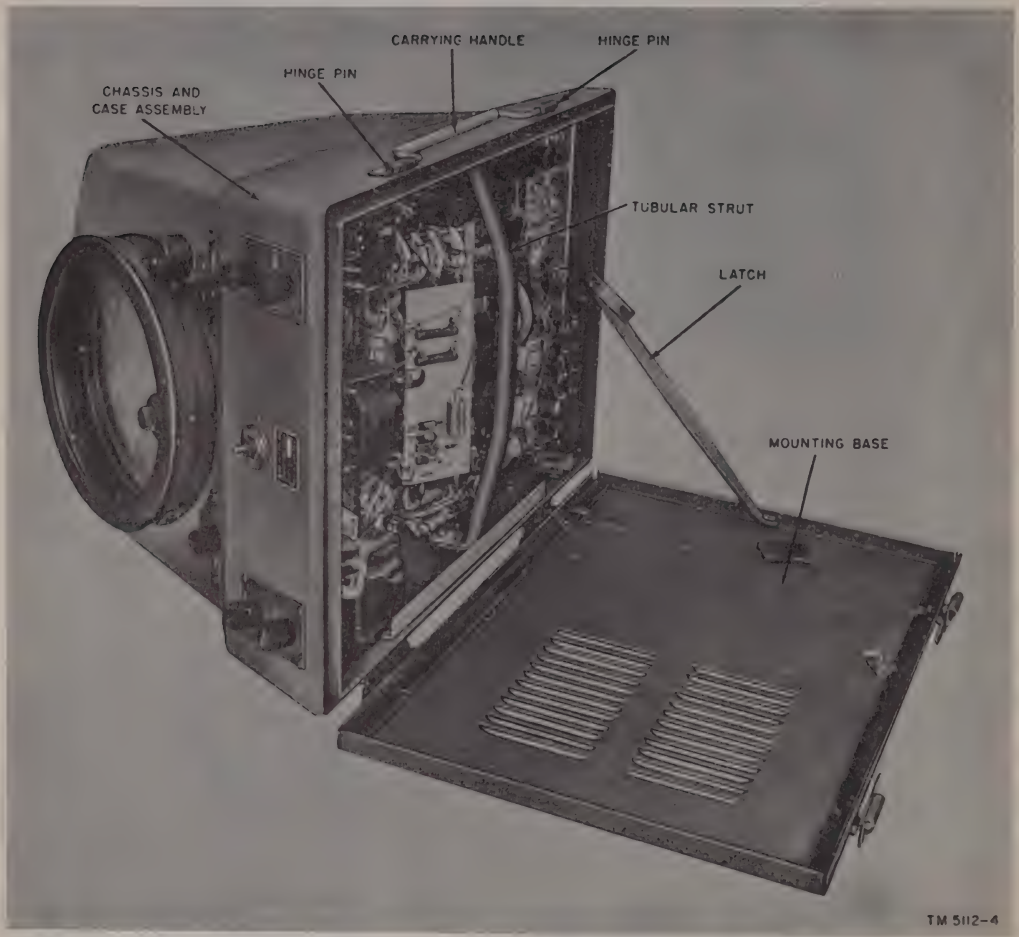


Figure 4. Azimuth and Range Indicator IP345/TPS-1D, mounting base opened.

CHAPTER 2
INSTALLATION

Section I. SERVICE UPON RECEIPT OF AZIMUTH AND RANGE INDICATOR IP-345/TPS-1D

11. Siting

a. The location of the remote ppi depends on the location of the master radar, the available shelter. For rated performance, place the remote ppi so that the maximum cable length between it and the master radar does not exceed 150 feet. The remote ppi is inclosed in a dripproof housing but is not designed for operation in exposed locations: therefore, suitable shelter must be provided at the operating site. When the remote ppi is used to furnish data for target plotting operations at a plotting board, place the unit so that the ppi screen will be within view of the plotting team. For the most effective use of the remote ppi, install it in a dimly lighted room or inclosure.

b. The remote ppi can be mounted in either the horizontal, vertical, or inverted position. However, to permit access to the interior of the unit provide approximately 11 inches clearance above the top cover to permit removal of the cover. A minimum space of approximately 17 inches also must be provided on one or both sides to permit the unit to swing open from the mounting base. Refer to figure 6 for a dimensional drawing of the unit.

12. Uncrating, Unpacking, and Checking New Equipment

(fig. 5)

Note. For used or reconditioned equipment, refer to paragraph 15.

a. General. When new equipment is received, select a location where the equipment may be unpacked without exposure to the elements and which is convenient to the permanent or semipermanent installation of the equipment.

Caution: Be careful when uncrating, unpacking, and handling the equipment; it is damaged easily.

b. Step-by-step Instructions for Uncrating and Unpacking.

(1) Place the packing container as near the operating position as is convenient.

(2) Cut and fold back the metal straps.

(3) Remove the nails from the top and one side of the case with a nail puller. Remove the top and side. Do not attempt to pry off the top and sides; the equipment may be damaged.

(4) Open the moistureproof barrier that covers the master carton inside the case. Remove the carton.

(5) Open the master carton and the moisture- vaporproof barrier within the carton. Remove and open the inner carton and remove the equipment.

Omit steps in (4) and (5) above if export packing is not used.

(6) Inspect the equipment for damage possibly incurred during shipment.

Checking. Check the contents of the shipping container against the master packing list.

Note. Save the packing case and cartons. They can be used again when the equipment is repacked for storage or shipment.

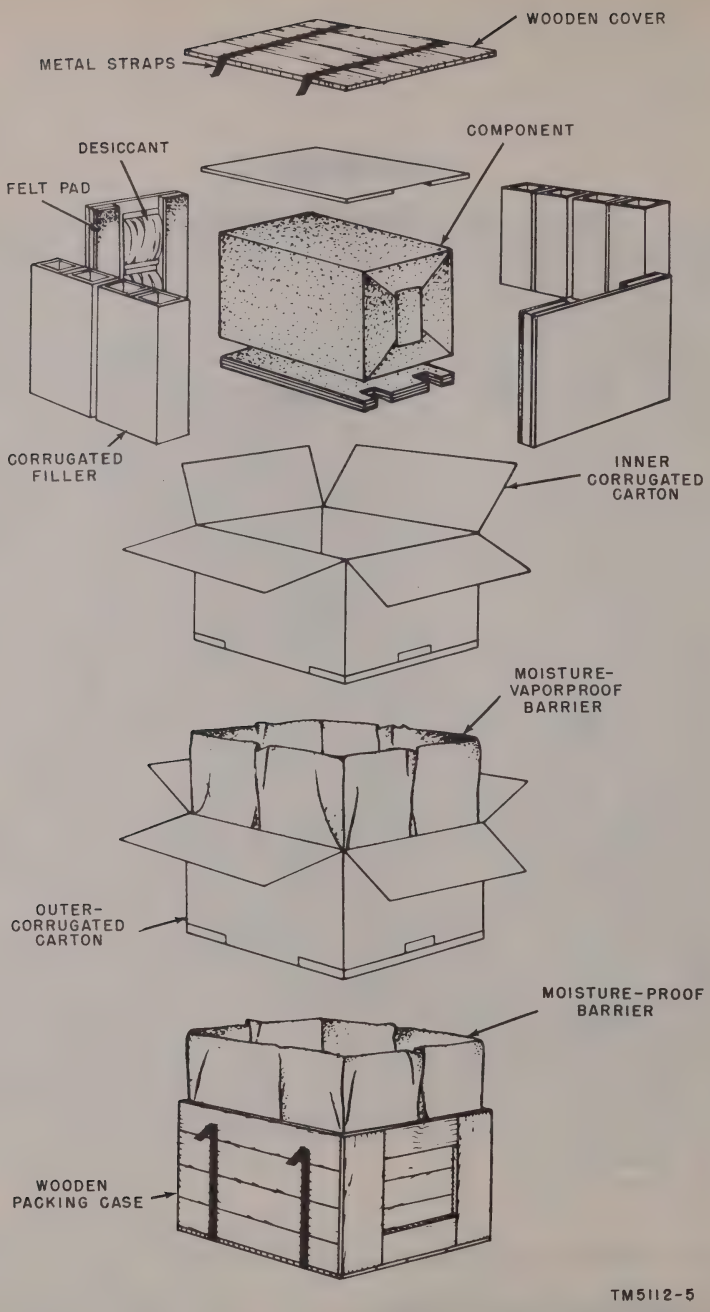


Figure 5. Typical packing and packaging diagram.

13. Installation of Azimuth and Range Indicator IP-345/TPS-1D

(fig. 7)

a. General. Azimuth and Range Indicator IP-345/TPS-1D can be mounted on a table or shelf, on a wall or vertical mounting surface, or on a ceiling or overhead structure. To install the remote ppi, first detach the mounting base and fasten it to the mounting surface. After the mounting base is securely fastened to the mounting surface, attach the case and chassis assembly to the mounting base.

b. Step-by-step Installation Instructions.

(1) Grasp the fluted sleeve on each carrying handle and rotate it counterclockwise to retract the hinge pins.

(2) When the hinge pins have been retracted from the half-hinge on the mounting base, carefully lift the case and chassis assembly off the mounting base.

(3) Use the mounting base as a template and mark the centers of the four mounting holes on the mounting surface.

(4) Use the proper size drill for the through bolts, lag screws, or other hardware to be used and drill the mounting holes.

(5) Secure the mounting base to the mounting surface with the through bolts or lag screws; tighten securely.

(6) Attach the case and chassis assembly to the mounting base. Turn the fluted sleeve on the carrying handles clockwise to engage the hinge pins into both half-hinges.

(7) If the remote ppi is mounted on a wall or other vertical mounting surface or on the ceiling or overhead, turn the name plate and marker plates around. Proceed as follows:

(*a*) Turn the DIMMER and MARKERS controls fully counterclockwise.

(*b*) Use an Allen wrench and loosen the set screws in the knobs on the DIMMER and MARKERS controls. Remove the knobs.

(*c*) Loosen and remove the four 4-40 machine screws and lock washers and remove the identification plate at the DIMMER and MARKERS control.

(*d*) Turn the identification plate over and reinstall it so that it will read properly from the operating position.

(*e*) Replace the knobs on the DIMMER and MARKERS controls.

(*f*) Follow the procedure in (*a*) through (*e*) above for the VIDEO GAIN and the IFF VIDEO GAIN controls.

(*g*) Loosen the hexagonal lock nut that secures the POWER-OFF switch to the front of the case. Remove the lock nut, lock washer, and identification plate.

(h) Turn the POWER-OFF identification plate over and reinstall it so that it will read properly from the operating position.

(*i*) Replace the lock washer and lock nut on the POWER-OFF switch. Tighten the lock nut.

(*j*) Loosen and remove the four machine screws and remove the INT and RANGE identification plates.

(*k*) Turn the INT and RANGE identification plates over and reverse their positions so that they will read properly from the operating position. When the RANGE identification plate is reversed, it becomes the INT identification plate; when the INT identification plate is reversed, it becomes the RANGE identification plate. Bolt the plates in position.

(*l*) Loosen and remove the four machine screws and remove the equipment name plate from the front of the equipment. Reverse the name plate and reinstall it so that it can be read from the operating position.

(*m*) Turn the azimuth dial around (par. 72) so that the 180° position is nearest to the operator when in the operating position.

c. Installation of Cathode-ray tube. Install the cathode-ray tube by following the instructions given in paragraph 72.

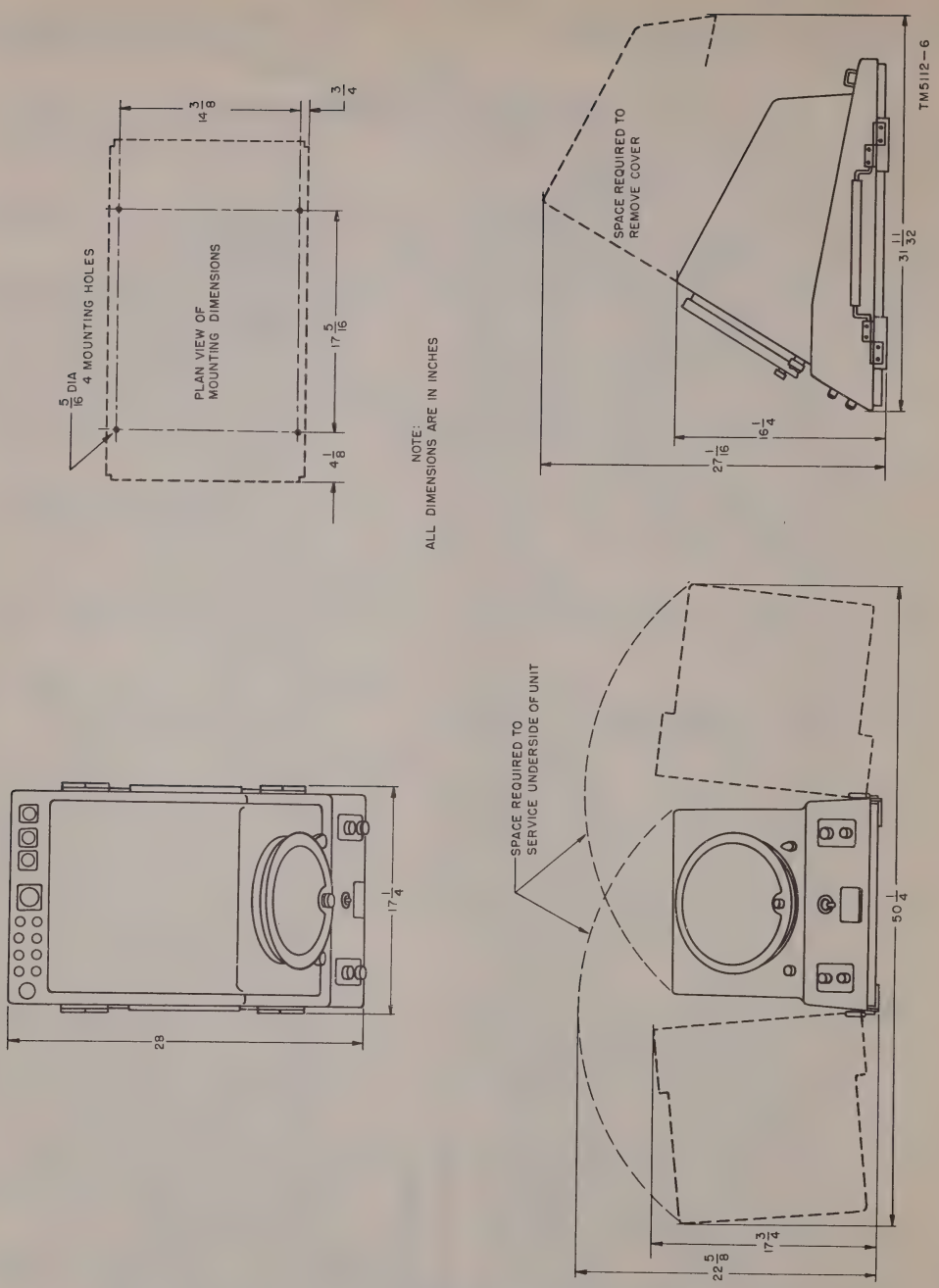


Figure 6. Azimuth and Range Indicator IP-345/TPS-1D, dimensional drawing.

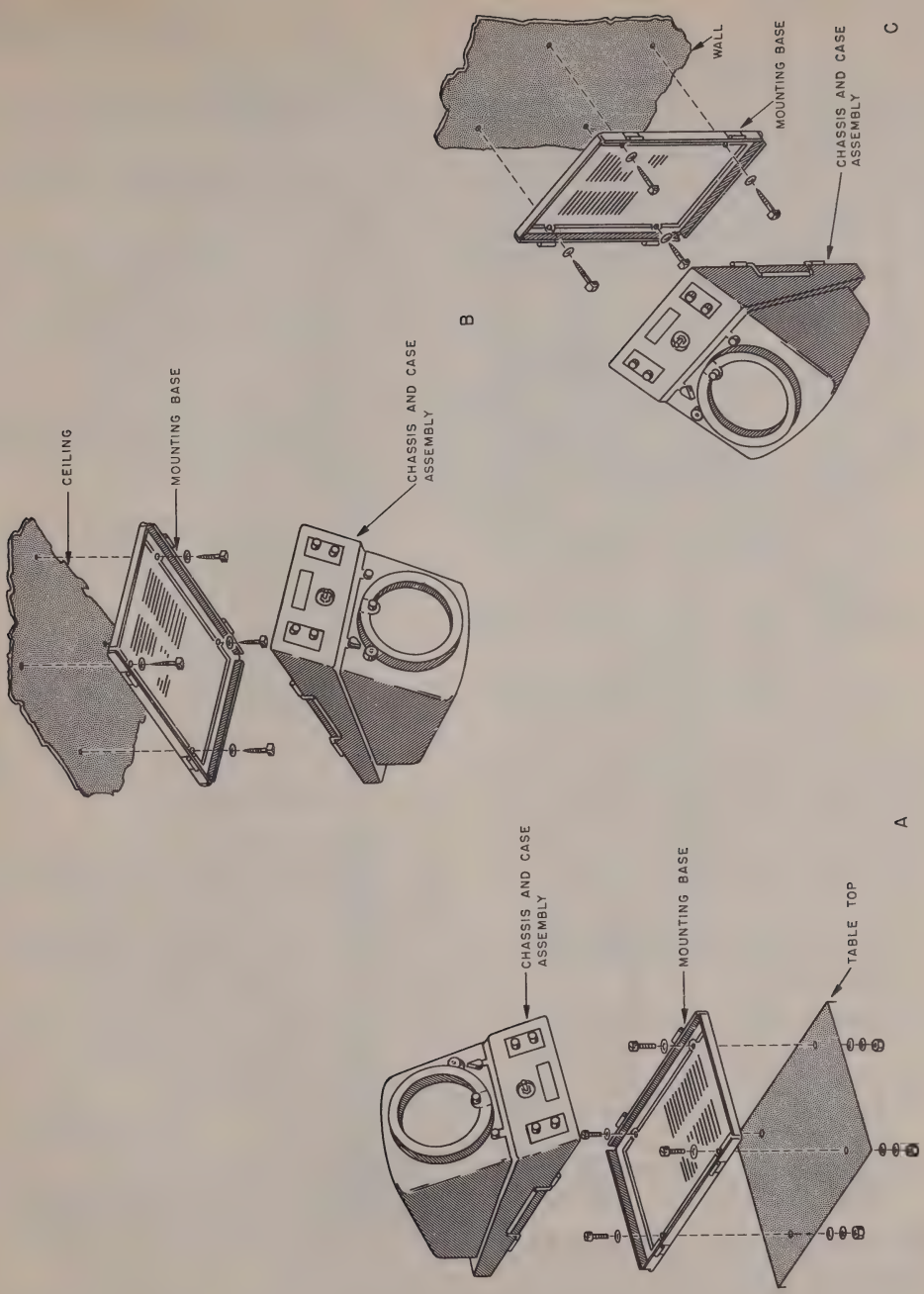


Figure 7. Azimuth and Range Indicator IP-345/TPS-1D, installation drawing.

14. Interconnections

a. General Cabling Instructions. Four cables are furnished for interconnections between Radio Set AN/TPS-1D and the remote ppi. These cables can be used for installations where not more than 25 feet of cable is required. For installations requiring more than 25 feet of cable, these cables must be fabricated (*d* below). The exact cable runs will vary with the installation; however, observe the following points when installing cables.

(1) Avoid sharp bends.

(2) Do not splice cable. If cable lengths must be joined, use mating connectors or a suitable junction box.

(3) Avoid running cables across a floor; if unavoidable, they should be protected with pipes, conduits, or other effective means.

(4) Keep cables away from steam or hot water pipes.

(5) Protect cables from continuous contact with oils and greases.

(6) Protect cables at all points where subject to abrasion or other damage.

b. Cable Installation With Radio Set ANT/PS-1D. Follow the step-by-step procedure given below for connecting the cables when using the remote ppi with Radio Set AN/TPS-1D (fig. 8).

(1) Connect P603 of trigger cable W1 to J603 at the rear of the remote ppi.

(2) Connect P414 of trigger cable W1 to J414 at the front of Power Supply PP-674/TPS-1D.

(3) Connect P604 of video cable W2 to J604 at the rear of the remote ppi.

(4) Connect P419 of video cable W2 to J419 at the front of Power Supply PP-674/TPS-1D.

(5) Connect P605 of iff video cable W3 to J605 at the rear of the remote ppi.

(6) Connect P418 of iff video cable W3 to a coaxial T-connector at IFF VID. PPI jack J417 at the front of Power Supply PP-674/TPS-1D. The other leg of the T is connected to VIDEO OUT jack J103 of Radio Receiver-Transmitter RT-211/TPX.

(7) Connect P602 of synchro cable W4 to J602 at the rear of the remote ppi.

(8) Connect P412 of synchro cable W4 to J412 at the front of Power Supply PP-674/TPS-1D.

(9) Connect P606 of power cable W5 to J606 at the rear of the remote ppi.

(10) Connect P1 of power cable W5 to a source of 115 volts, 60 cycle alternating current (ac) (par. 4).

(11) Remove the remote ppi trigger terminating resistor from the trigger circuit at Power Supply PP-674/TPS-1D as follows (fig. 9):

(*a*) Loosen the eight captive screws at the front of Power Supply PP-674/TPS-ID and draw the unit part way out of the case.

(*b*) Open the small spring-loaded door at the lower right-hand side of the drawn-out unit and remove the jumper between R446 and R448.

(*c*) Close the spring-loaded door, slide the unit back into the case, and tighten the captive screws.

c. Cable Chart. The following chart lists the cables supplied with Azimuth and Range Indicator IP-345/TPS-1D for use with Radio Set AN/TPS-1D.

Cable No.	*Connects*		*Purpose*
	From	*To*	
W1	J414, Power Supply PP-674/TPS-1D	J603	Trigger input
W2	J419, Power Supply PP-674/TPS-1D	J604	Radar video input
W3	J417, Power Supply PP-674/TPS-1D	J605	Iff video input
W4	J412, Power Supply PP-674/TPS-1D	J602	Synchro data and excitation
W5	115-volt, 60-cycle source	J606	Power input

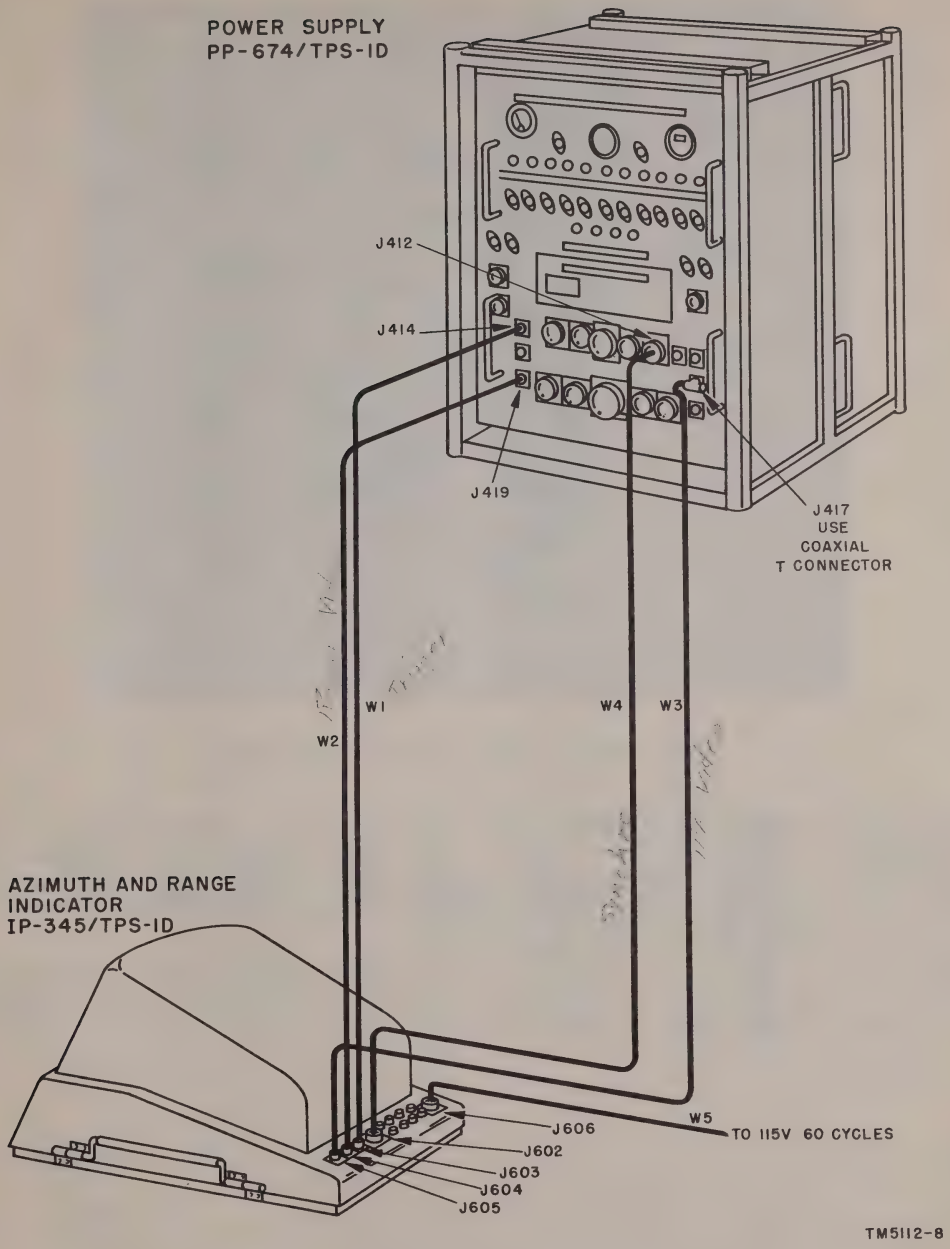


Figure 8. Azimuth and Range Indicator IP345/TPS-1D, pictorial cabling diagram.

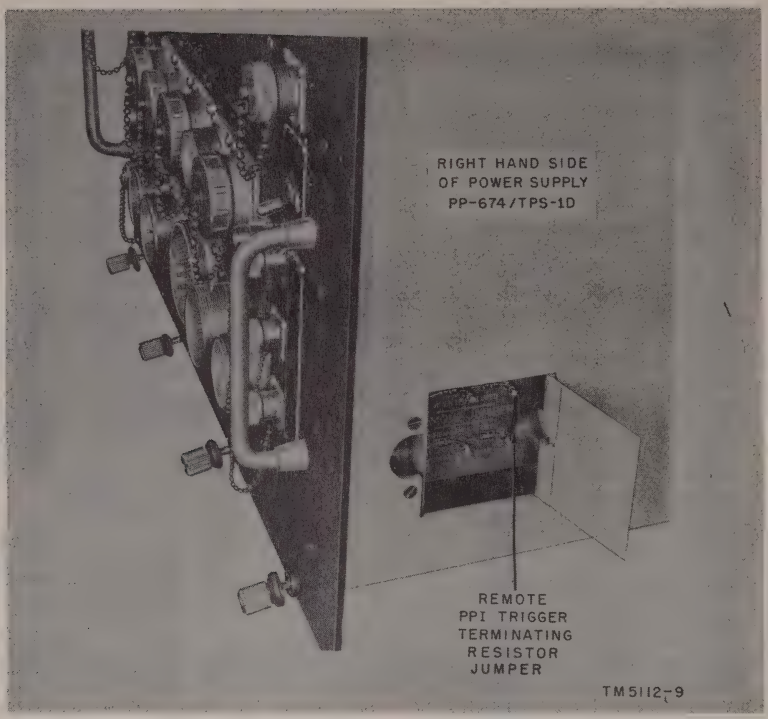


Figure 9. Remote ppi trigger terminating resistor jumper.

d. Cable Fabrication. In installations that require a greater cable length than the 25-foot lengths supplied with the equipment, new cables must be fabricated. For the video, trigger, and iff cables, use coaxial Cable RG-6A/U and Connectors UG-18C/U on each end. Assemble according to the instructions given in figure 10. For synchro cable (W4), use type CO-05MGF-(5/18)0495 (per MIL-C-3432) multiconductor cable and a type AN3106A-28-1P connector plug, AN3055-28-10 adapter, and AN3057-10A cable clamp on each end. Assemble according to the instructions given in figures 11 and A, 12.

Note. Fabrication of the power cable is not required. The power source outlet should be located so that power cable W5, which is supplied with the equipment, can be used.

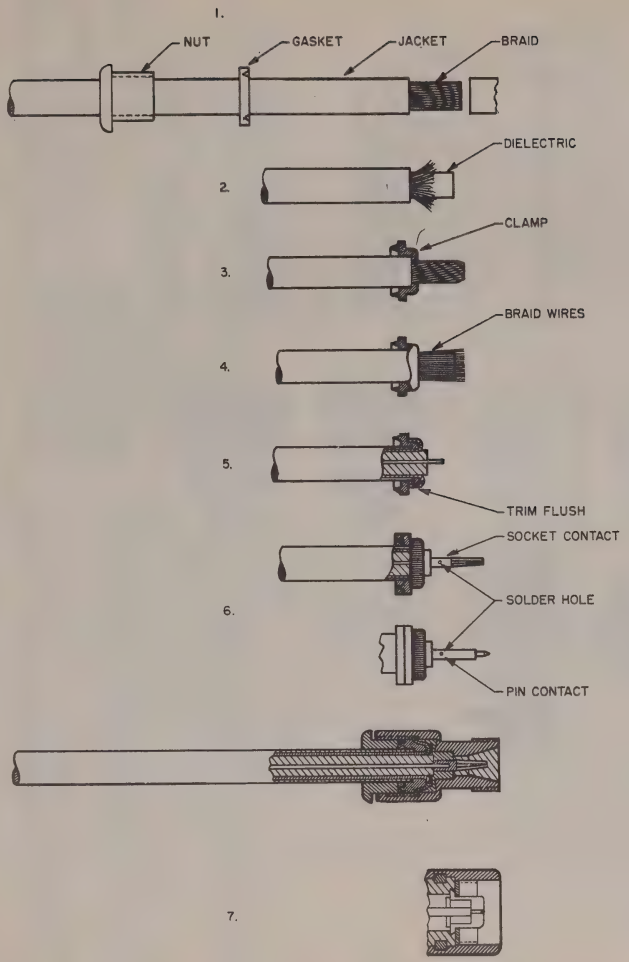


Figure 10. Assembly of Connector UG-18C/U to Cable RG-6A/U.

PROCEDURE

1. CUT CABLE OFF SQUARE AND EVEN. SLIDE NUT AND GASKET OVER JACKET. STRIP JACKET TO EXPOSE BRAID 11/16 INCH FROM END OF CABLE, BEING CAREFUL NOT TO CUT OR NICK BRAID.

2. FLARE END OF BRAID AS SHOWN AND CUT OFF DIELECTRIC AND CENTER CONNECTOR 9/16 INCH FROM END OF JACKET.

3. SMOOTH OUT FLARE IN BRAID AND TAPER DOWN OVER END OF DIELECTRIC. SLIDE CLAMP OVER BRAID AND PUSH IN PLACE UNTIL JACKET SEATS FIRMLY AGAINST INTERNAL SHOULDER OF CLAMP.

4. COMB OUT BRAID WIRES EXTENDING BEYOND CLAMP, BEING CAREFUL NOT TO DAMAGE THE DIELECTRIC MATERIAL.

5. FOLD BACK BRAID WIRES OVER TAPERED SURFACE OF CLAMP AND TRIM OFF BRAID WIRE ENDS FLUSH WITH SHOULDER OF CLAMP AS SHOWN. MAKE SURE TO ELIMINATE ALL CROSSOVERS IN THE WIRES. CUT DIELECTRIC OFF SQUARE 3/64 INCH FROM BRAID, BEING VERY CAREFUL TO AVOID CUTTING CENTER CONDUCTOR ESPECIALLY IF IT IS STRANDED WIRE. TIN CENTER CONDUCTOR PREFERABLY BY QUICK DIP IN SOLDER POT TO PREVENT OVERHEATING AND CONSEQUENT SWELLING OF DIELECTRIC. CUT OFF CENTER CONDUCTOR 3/16 INCH FROM END OF DIELECTRIC.

6. SMOOTH CONDUCTOR WITH A FINE FILE UNTIL IT CAN BE INSERTED INTO CONTACT. IT IS IMPORTANT THAT CONTACT BE FLUSH WITH DIELECTRIC. PUSH CONTACT OVER CENTER CONDUCTOR UNTIL SEATED AGAINST DIELECTRIC AND SECURE CONTACT TO CONDUCTOR WITH SOFT SOLDER. SLIDE GASKET FORWARD UNTIL PROPERLY SEATED IN CLAMP KNIFE EDGE.
NOTE:
ASSEMBLY FOR SOCKET CONTACT SHOWN BUT PIN CONTACT IS ASSEMBLED IN THE SAME MANNER.

7. INSERT CONTACT INTO CONNECTOR BODY GUIDING CONTACT THROUGH HOLE IN INSULATOR AND PUSHING ASSEMBLY FORWARD UNTIL BRAID IS CLAMPED SECURELY BETWEEN SURFACES OF CLAMP AND BODY. SLIDE NUT FORWARD TO BODY AND SCREW INTO BODY WITH WRENCH, KEEPING CABLE STATIONARY WITH RESPECT TO BODY UNTIL SUFFICIENT PRESSURE IS APPLIED TO SPLIT GASKET AND INSURE GOOD CONTACT BETWEEN NUT AND CLAMP.
NOTE:
RECEPTACLE CONNECTOR SHOWN BUT PROCEDURE IS SAME FOR CORRESPONDING PLUG ASSEMBLY.

TM5112-10

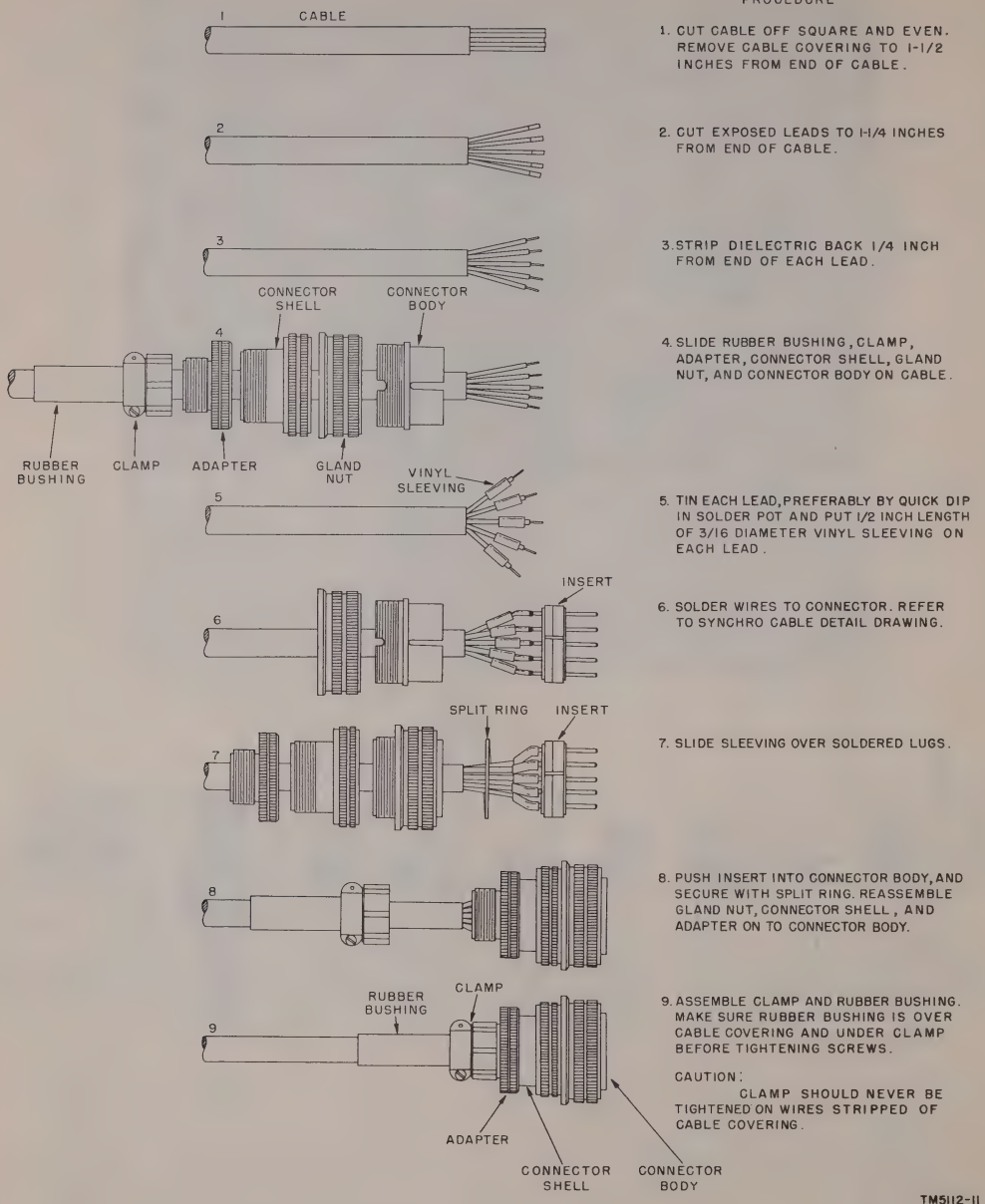
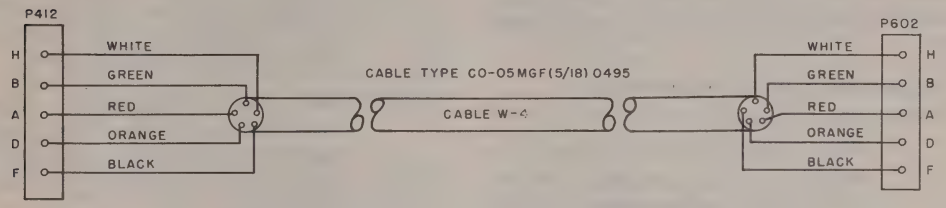


Figure 11. Assembly of type AN3106 connectors to synchro cable.

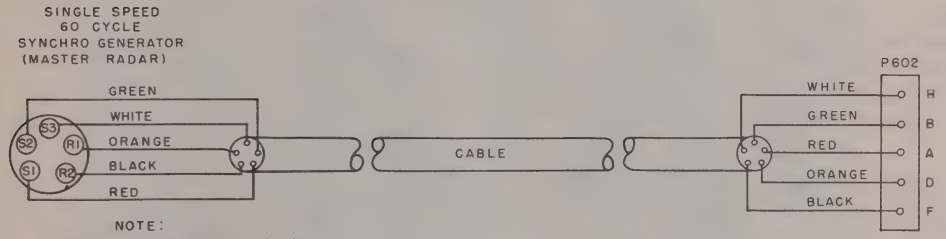
e. Cable Installation, Master Radar Other Than Radio Set AN/TPS-1D. When the remote ppi is used with a master radar other than Radio Set AN/TPS-1D, the cable make-up will depend upon the master radar used; therefore, specific and detailed instructions for cabling cannot be supplied. The following subparagraphs list general points to be observed when cabling the remote ppi to a master radar.

(1) Trigger and video pulses supplied by the master radar must be within the limits described in paragraph 4. The remote ppi provides 75-ohm terminations for trigger and video inputs.

(2) The master radar must supply synchro data for single speed synchro operation. Excitation voltage (115 volts, 60 cycles) is furnished by the remote ppi. Refer to figure 12 for synchro cable connections.



A SYNCHRO CABLE FOR USE WITH RADIO SET AN/TPS-1D



NOTE:
P412 AND P602 CONSIST OF THE FOLLOWING:

CONNECTOR PLUG	AN3106-28-1P
ADAPTER	AN3055-28-10
CABLE CLAMP	AN3057-10A

B SYNCHRO CABLE FOR USE WITH TYPICAL MASTER RADAR SET

TM5112-12

Figure 12. Synchro cable, detail drawing.

15. Service Upon Receipt of Used or Reconditioned Equipment

a. Follow the instructions given in paragraph 12 for uncrating, unpacking, and checking the equipment.

b. Check the used or reconditioned equipment to see whether it has been changed by a Modification Work Order (MWO). If modified, the MWO number will appear on the front panel near the nomenclature plate. Indicate the MWO number on the schematic diagram (fig. 59).

c. Check the operating controls for ease of rotation. If lubrication is required, refer to the lubrication instructions in paragraphs 34 and 35.

d. Perform the installation and connection procedures given in paragraphs 13 and 14.

Section II. INITIAL ADJUSTMENTS

16. General

This section covers initial alignment procedures that should be performed after installation and prior to initial operation. Adjustments that require the use of specialized test equipment are given in chapter 6. The alignment procedures that follow require that the unit be energized. To energize the equipment, turn the MARKERS and INT controls (fig. 17) fully counterclockwise and turn the POWER-OFF switch to the POWER position. Allow approximately 5 minutes for the equipment to warm up.

17. Performing Initial Adjustments

a. Synchro Alignment.

(1) Place the master radar antenna in the zero (true north) position. Place the single speed synchro generator (B753 in Radio Set AN/TPS-1D) at the master radar in the electrical zero position. Follow the instructions given in the manual furnished with the master radar. Placing B753 in the electrical zero position will facilitate changing synchros and will simplify alignment when using more than one master radar with the remote ppi.

(2) Turn on the master radar and energize the remote ppi (par. 16). Adjust the INT control so that a sweep is visible on the cathode-ray tube.

(3) Loosen the two clamps and carefully rotate the body of synchro control transformer B602 (fig. 13) until the sweep is at 0°. Tighten the clamps securely.

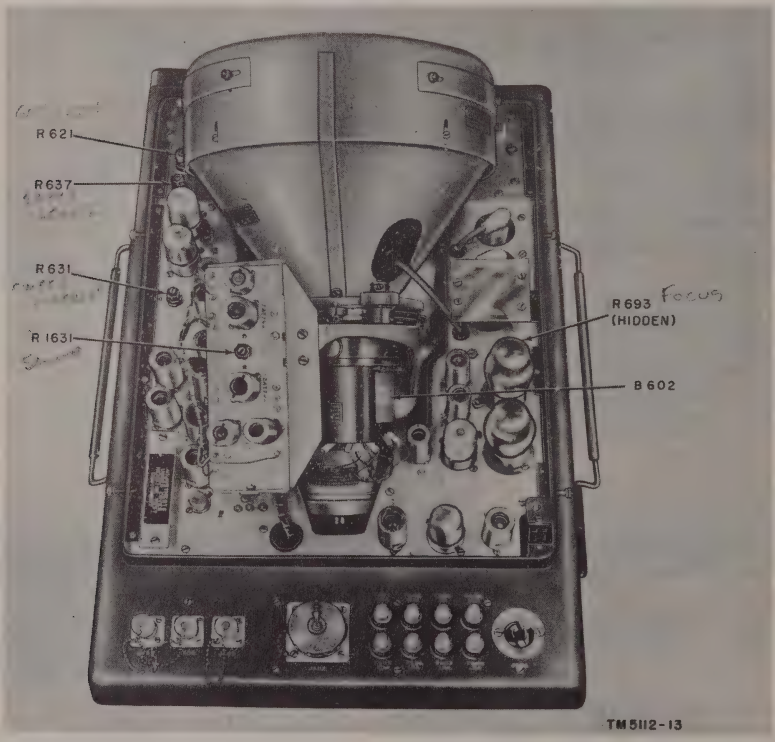


Figure 13. Azimuth and Range Indicator IP-345/TPS-1D, screw-driver adjustments.

b. Mechanical Focusing and Centering Alignment. The two magnet assemblies on the neck of the cathode-ray tube are for centering the electron beam in the electron gun, thereby providing centering and auxiliary focusing facility. Focus control R693 is a screw-driver control located to the left of the crt in front of V601 on the top of the chassis, (fig. 13). The procedure for adjustment of the focusing magnet and the centering magnet assemblies is as follows (fig. 14 and 15).

(1) Check to see that the focusing and centering magnet assemblies are free to rotate on the tube neck but tight enough to remain fixed under normal conditions of shock and vibration (par. 72).

(2) Turn on the master radar and energize the remote ppi. Adjust the INT control for a visible sweep on the cathode-ray tube. Do not rotate the master radar antenna.

(3) Turn the RANGE control to the 40 position and turn up the MARKERS control until the range markers are of moderate brightness.

(4) Adjust the knurled knob on the focusing magnet assembly roughly for maximum intensity; readjust INT control for a barely visible sweep trace. This knurled knob will move the sweep origin.

(5) Rotate the centering magnet assembly on the neck of the tube. Note the path and limits of the excursion of the sweep origin as it moves (A, fig. 15). If the origin of the sweep does not pass through the tube center (under the intersection of the two cursor lines), adjust the knurled knob on the centering magnet so that the sweep origin is midway between the limits of its excursion (B, fig. 15).

(6) Rotate the centering magnet assembly on the tube neck until the sweep origin can be made to pass through the tube center by turning the knurled knob on the centering magnet (C, fig. 15). This preliminary adjustment need not be precise but should bring the sweep origin to within ⅛ inch of the center (D, fig. 15).

(7) Adjust focus control R693 (fig. 13) so that the best compromise between minimum spot size of the range markers and minimum intensity of the halo (ring around range markers) is obtained.

(8) Turn up the MARKERS control until the markers are bright and notice the markers near the sweep origin. The halo around the markers should be symmetrically distributed about the focused range marker spot.

(9) If the halo is not symmetrically distributed about the range marker spots, adjust the knurled knob on the focusing magnet (fig. 14) to make the halo symmetrical.

(10) If it is impossible to make the halo symmetrical with respect to the markers when the above procedure is followed, rotate the focusing magnet assembly about 30° and repeat the procedure given in (9) above.

(11) Repeat the instructions as given in (9) and (10) above until the halo is symmetrical with respect to the markers.

(12) Repeat the procedure given in (5) and (6) above to center the origin of the sweep precisely.

(13) In extreme cases it may be necessary to repeat the procedure given in (4) through (12) above two or three times to get optimum focus together with precise centering.

(14) Turn the MARKERS control down for normal marker intensity. Rotate the antenna and check the focus at different positions. If the adjustment has been made properly, no change in focusing should occur with rotation.

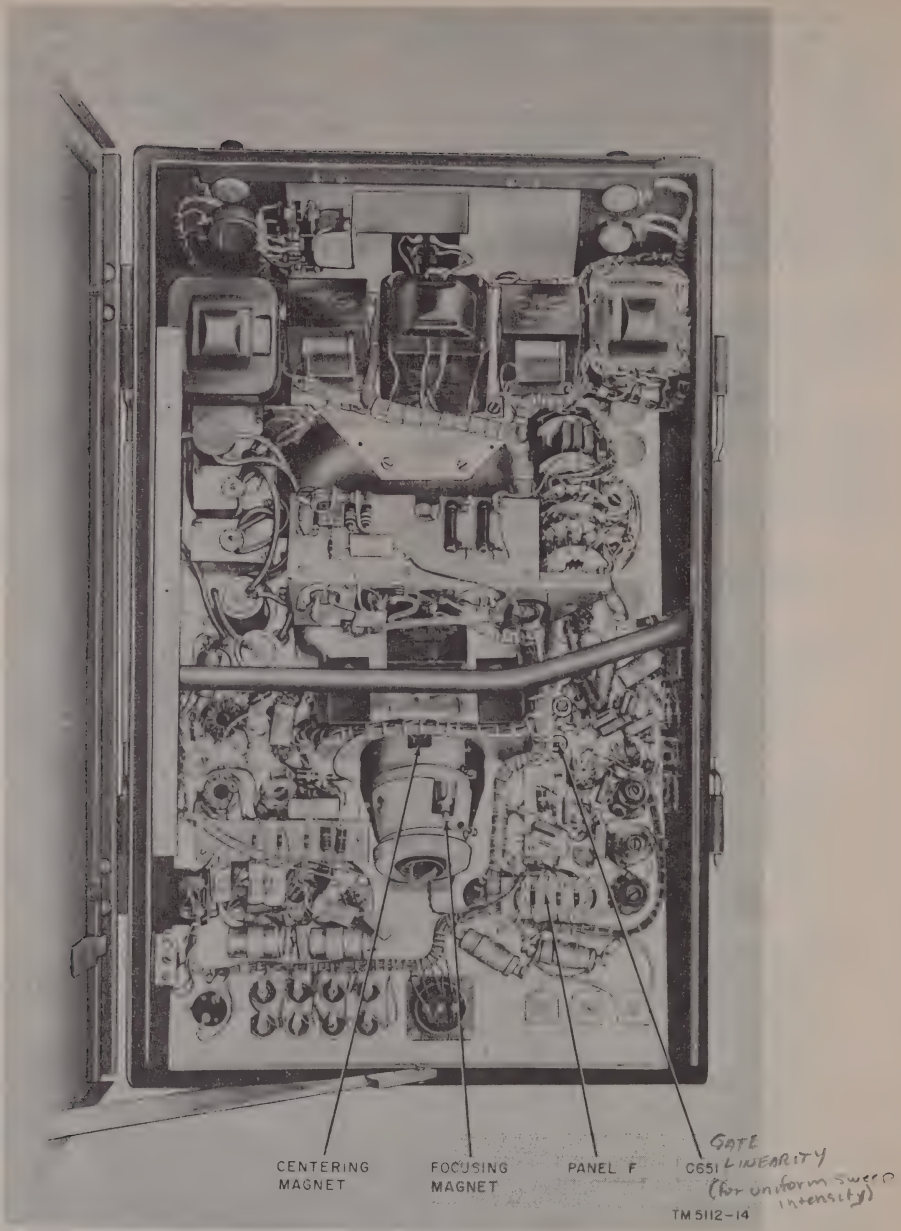


Figure 14. Location of focusing and centering magnet assemblies.

c. Servo Gain Adjustment. With the master radar and the remote ppi turned on, advance servo gain control R1631 (fig. 13) until the servo amplifier causes the deflection coil gears

and sweep to oscillate; then back off slightly from that position until the oscillation stops. If the gears do not oscillate at the maximum setting of R1631, leave this adjustment at the maximum clockwise position.

d. Marker Selection Jumpers. Two alternative range marker intervals can be selected by jumpers on panel F (fig. 14). The jumper connections for the alternate range marker displays are as follows:

(1) *For 10-mile markers on all ranges.* To display 10-mile range markers on all ranges, make the following jumper connections on panel F (A, fig. 16).
   (*a*) Connect a jumper from A to K and to G.
   (*b*) Connect a jumper from C to J and to E.

(2) *For 10,000-yard and 50,000-yard markers.* To display 10,000-yard mark-

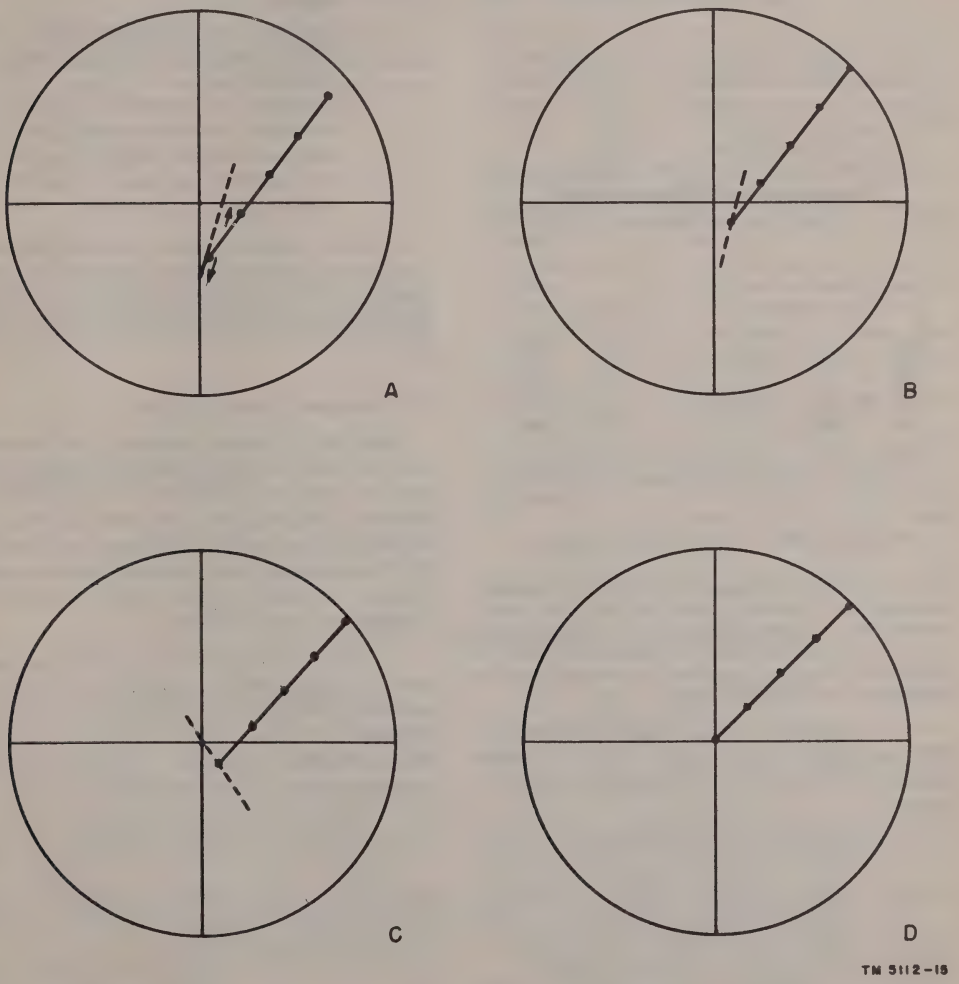


Figure 15. Adjustment of focusing and centering magnet assemblies.

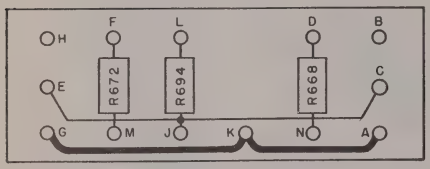
ers on the 20- and 40-mile ranges and 50,000-yard markers on the 80- and 160-mile ranges, make the following jumper connections on panel F (B, fig. 16).

(*a*) Connect a jumper between A and B.

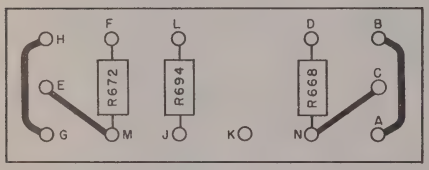
(*b*) Connect a jumper between C and N.

(*c*) Connect a jumper between E and M.

(*d*) Connect a jumper between G and H.



A. 10 MILE MARKER JUMPERS



B. 10,000 AND 50,000 YARD MARKER JUMPERS

TM5112-16

Figure 16. Range marker selector jumpers.

Note. Before performing the following alignment procedures in *e* through *g* below, turn the INT control clockwise for a reasonably bright sweep trace and then rotate the master antenna and the sweep about 10 revolutions. This action equalizes the static charge on the face of the cathode-ray tube.

e. For 160-mile Gate Length Adjustment. With a trigger input supplied from the master radar and the remote ppi energized, proceed as follows:

(1) Place the RANGE switch in the 160 position and turn up the MARKERS control to display the range markers.

(2) Adjust 160-mile gate length control R621 (fig. 13) so that the sweep ends just beyond the 160-mile marker.

f. Sweep Step and Slope Adjustments. The following two adjustments affect the linearity of the sweep and are interactive. To make these adjustments proceed as follows:

(1) Adjust sweep slope R637 so that the 160-mile marker is within approximately ¼-inch of the edge of the usable portion of the cathode-ray tube.

(2) Adjust step control R631 for the best possible linearity on the 160-mile sweep. The linearity of this sweep can best be indicated by displaying the 10-mile markers (*d* above) and examining these markers for regularity of spacing.

(3) Recheck the R637 and R631 adjustments, because these adjustments are interactive.

(4) Perform the procedure given in (1) through (3) above at each of the other positions of the RANGE switch (80, 40, and 20). Adjust it for the best compromise on all ranges.

g. Gate Regulator Adjustment. Operate the remote ppi with the RANGE switch in the 160 position and adjust C651 (fig. 14) so that the intensity along the sweep line is as uniform as possible.

18. Preoperational Checks

Make the following preoperational checks on the remote ppi prior to placing the unit in operation. These preoperational checks, except the deflection coil tracking (the first) and the video amplifier (the last), can be made either with the master radar connected or with a positive trigger supplied by test equipment, such as Oscilloscope AN/USM-24.

a. Check to see that the remote ppi sweep correctly indicates the azimuth bearing of the master radar antenna. Rotate the master radar antenna clockwise and check to see that the sweep rotates clockwise and closely follows the movements of the antenna.

b. Check to see that the sweep and markers are properly centered and focused.

c. Check to see that there are the correct number of range markers on each of the four sweep ranges and that the sweeps are linear and of uniform intensity.

d. Advance the VIDEO GAIN control and check for noise (sparkle) or echoes on the cathode-ray tube.

CHAPTER 3
OPERATION

Section I. CONTROLS AND INSTRUMENTS

Note. This section locates, illustrates, and describes the uses of the various controls and instruments that are provided for the proper operation of the equipment.

19. General

It is important to know the function of every control. The actual operation of the equipment is discussed in the next section of this manual.

20. Controls and Their Uses
(fig. 17)

The following table lists the controls of the remote ppi and indicates their function:

Control	*Function*
POWER-OFF switch (S601)	In POWER position, applies ac power to remote ppi circuits. In the OFF position, heater HR601 (if installed) is energized.
INT control (R687)	Controls brilliance of display on cathode-ray tube.
RANGE switch (S604)	Selects 20-, 40-, 80-, or 160-mile sweep ranges.
DIMMER control (R1624)	Controls brilliance of lighting of cursor lines and azimuth scale at reflection plotter.
MARKERS control (R679)	Controls intensity of fixed range markers displayed on cathode-ray tube.
VIDEO GAIN control (R651)	Controls level of radar video applied to cathode-ray tube.
IFF VIDEO GAIN control (R1621)	Controls level of iff video applied to cathode-ray tube.
Cursor control knob	Controls rotation of cursor (cursor consists of two lines at right angles that can be rotated approximately 100°).

Section II. OPERATING UNDER USUAL CONDITIONS

21. Starting and Stopping Procedure

When using the remote ppi for observing targets intercepted by the master radar, follow the starting and stopping procedure given in this paragraph. It is assumed that the equipment has been adjusted as described in paragraphs 16, 17, and 18.

a. Preliminary Control Settings. Make the following preliminary control settings:

(1) Turn the INT control fully counterclockwise.

(2) Turn the MARKERS control fully counterclockwise.

b. Starting Procedure.

(1) Turn POWER-OFF switch to the POWER position.

(2) Turn the INT control clockwise until a faint sweep trace appears on the cathode-ray tube.

(3) Turn the RANGE switch to select the desired sweep range.

(4) Adjust the VIDEO GAIN control for the desired brightness of echo. A

VIDEO GAIN setting that is too high results in large saturated areas of uniform brightness on the cathode-ray tube screen and consequently poor target definition; a VIDEO GAIN setting that is too low may cause targets to be missed altogether.

(5) Adjust the IFF VIDEO GAIN control for the desired brightness of iff signal. In the absence of iff video signals, adjust this control to the same relative position as the VIDEO GAIN control.

c. Stopping Procedure. Turn the POWER-

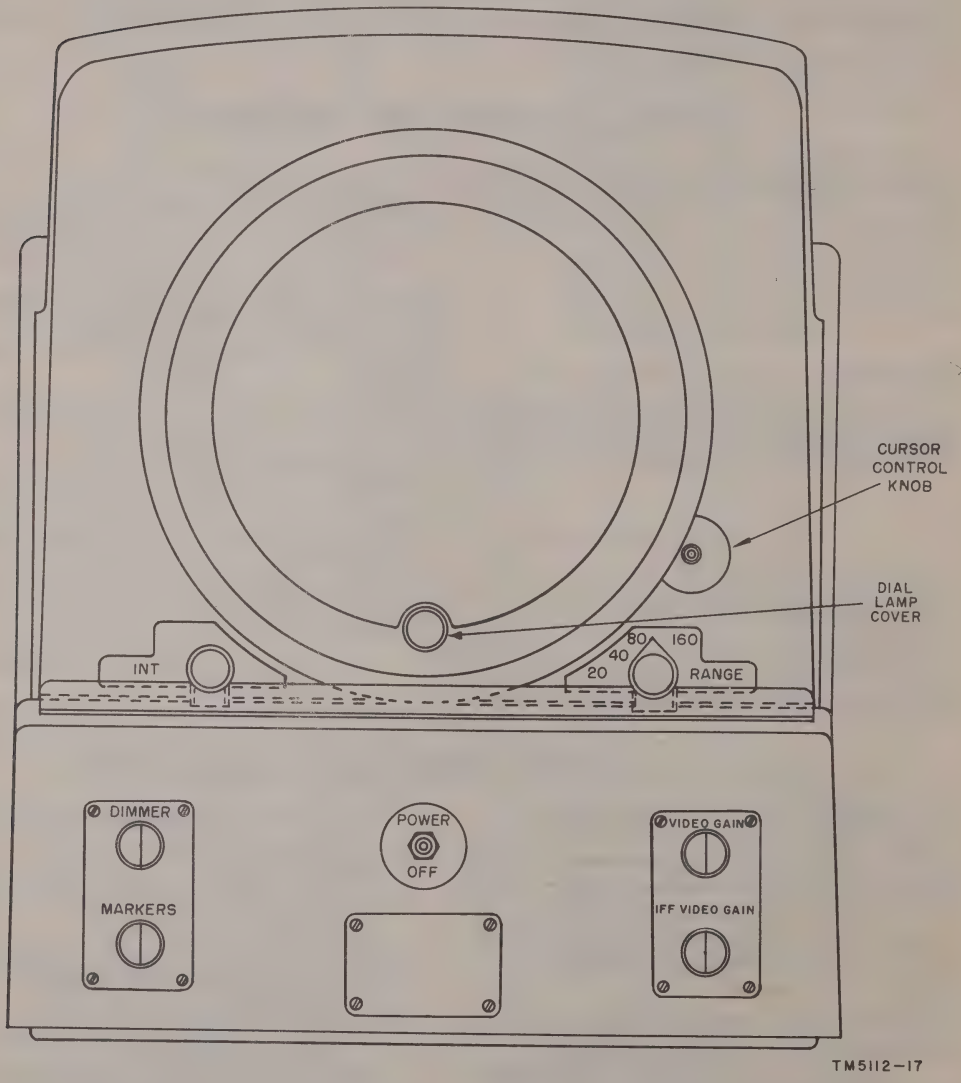


Figure 17. Azimuth and Range Indictor IP-345/TPS-1D, operating controls.

OFF switch to the OFF position.

Note. Heater HR601 is installed in some equipments and is energized when the POWER-OFF switch is in the OFF position. To remove power from HR601, unplug power cable W5 from the power source.

22. Determining Bearing and Range

The bearing and range of any point on the map-like presentation of the cathode-ray tube can be determined by the azimuth scale and range markers.

a. Bearing.

(1) Turn the DIMMER control until the cursor lines and the azimuth scale are illuminated to the desired brilliance.

(2) Turn the cursor control knob so that one of the cursor hairlines bisects the target.

(3) Read the azimuth bearing where the cursor line falls on the azimuth scale.

b. Range.

(1) Turn up the MARKERS control to display range markers on the cathode-ray tube.

(2) Determine the range of the target by comparing its position with that of the range markers.

c. Viewing Hood. A viewing hood or light shield is supplied for attachment to the cover assembly. This is used when the remote ppi is operated in a well-lighted area. To attach the viewing hood simply snap it over the cathode-ray tube window rim (fig. 18).

23. Plotting

a. The remote ppi is provided with a reflection plotter (fig. 3) upon which direct plots can be made. The reflection plotter is designed so that a mark made with a grease pencil on the surface will be reflected to the surface of the cathode-ray tube directly below it. This reflection will appear at the same point regardless of the angle from which it is viewed. This makes it possible to record easily and accurately, on the outer surface of the window, the position of the target that appears on the cathode-ray tube screen. Therefore, plots for determining the course and speed of moving

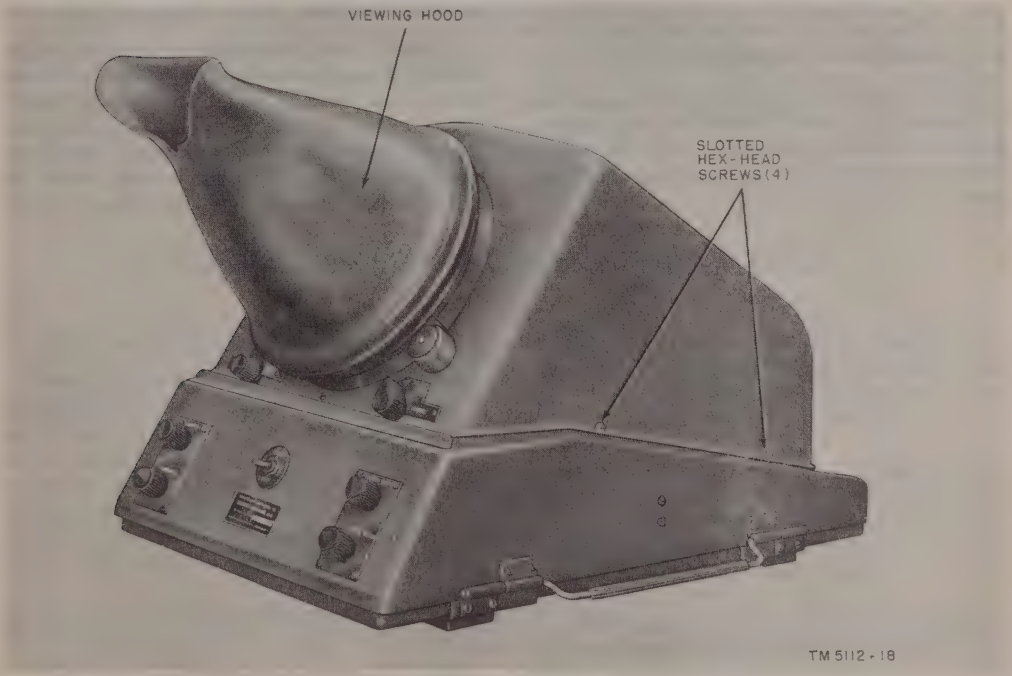


Figure 18. Azimuth and Range Indicator IP-345/TPS-1D, viewing hood attached.

targets intercepted by the master radar can be made directly on the cathode-ray tube window.

b. Target data may be obtained from the remote ppi for use in plotting on a plotting board. To furnish data to a plotter, an azimuth scale graduated in mils can be installed in place of the one graduated in degrees. Refer to paragraph 72 for detailed procedure for installing the mil dial in the cover assembly.

Section III. OPERATION UNDER UNUSUAL CONDITIONS

24. General

The operation of Azimuth and Range Indicator IP-345/TPS-1D may be difficult in regions where extreme cold, heat, moisture, sand conditions, etc., prevail. Procedures for minimizing the effect of these unusual operating conditions are outlined in the following paragraphs.

25. Operation in Arctic Climates

Subzero temperatures and climatic conditions associated with cold weather may affect the efficient operation of the equipment. Keep the equipment warm and dry if possible.

26. Operation in Tropical Climates

When operated in tropical climates, protect the remote ppi against excessive moisture conditions as much as possible. Keep the equipment as well-ventilated as operating conditions permit.

27. Operation in Desert Climates

a. The main problem that arises with equipment operation in desert areas is the large amount of sand, dust, or dirt that enters the moving parts of the deflection coil drive mechanism. The ideal preventive precaution is to house the equipment in a dustproof shelter. Such a building is seldom available and would require air conditioning; therefore, the next best precaution is to make the building in which the equipment is located as dustproof as possible with available materials.

b. Never tie power cords, cables, or other wiring connections to either the inside or outside of tents. Desert areas are subject to sudden squalls that may jerk the connections loose or break the lines.

c. Keep the equipment as free from dust as possible. Make frequent preventive maintenance checks (par. 31, 32, and 33). Pay particular attention to the lubrication at the deflection coil gear train. Excessive amounts of dust, sand, or dirt that come into contact with grease result in grit, which will damage the equipment.

CHAPTER 4
ORGANIZATIONAL MAINTENANCE

Section I. ORGANIZATIONAL TOOLS AND EQUIPMENT

28. General

The tools, parts, supplies, and test equipment necessary to perform organizational maintenance are authorized by appropriate publications. Additional tools and testing facilities may be supplied with any particular equipment.

29. Tools and Materials Required and Supplied

a. The following tools and materials are required for organizational maintenance of the remote ppi.

(1) Screw driver.
(2) Tube checker.
(3) Ohmmeter.
(4) Sandpaper #0000.
(5) Lint-free cloth.
(6) Cleaning Compound (Federal stock No. 7930-395-9542).

b. No special tools are supplied with Azimuth and Range Indicator IP-345/TPS-1D. However, the tools that are normally supplied with Radio Set AN/TPS-1D, or other master radar set with which this equipment is used, will usually be enough for all purposes at the organizational level.

Section II. PREVENTIVE MAINTENANCE SERVICE

30. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good working order so that breakdowns and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from trouble shooting and repair since its object is to prevent certain troubles from occurring.

31. General Preventive Maintenance Techniques

a. Use #000 sandpaper to remove corrosion.
b. Use a clean dry lint-free cloth or dry brush for cleaning. If the dry cloth or brush will not remove the dirt, use a cloth or brush moistened with Cleaning Compound. When the parts are clean, wipe them dry with a cloth.

Caution: Repeated contact of Cleaning Compound with the skin or prolonged breathing of the fumes is dangerous. Be sure adequate ventilation is provided. Cleaning Compound is flammable; do not use near a flame.

c. For further information on preventive maintenance techniques, refer to TB SIG 178, Preventive Maintenance Guide for Radio Communication Equipment.

32. Use of Preventive Maintenance Forms (fig. 19 and 20)

a. DA Form 11-238 is a preventive maintenance check list to be used by the operator as directed by his commander.

b. DA Form 11-239 is a preventive maint-

OPERATOR FIRST ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT
RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE: AZIMUTH AND RANGE INDICATOR IP-345/TPS-1D — EQUIPMENT SERIAL NO. 000

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; Ⓧ Defect corrected.
NOTE: Strike out items not applicable.

DAILY

NO.	ITEM	CONDITION S	M	T	W	T	F	S
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT ~~(receiver, transmitter, carrying cases, wire and cable, telephones, tubes, spare parts, technical manuals and accessories)~~. PAR. 9, 39, 40	✓	✓	✓	✓	✓	✓	✓
2	~~LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION.~~							
3	CLEAN DIRT AND MOISTURE FROM ~~ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS,~~ JACKS, PLUGS, ~~TELEPHONES, CARRYING CASE,~~ COMPONENT PANELS. FIG. 8	✓	✓	✓	✓	✓	✓	✓
4	~~INSPECT SEATING OF READILY ACCESSIBLE "PLUG-IN" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS.~~							
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. FIG. 17	✓	✓	✓	✓	✓	✓	✓
6	CHECK FOR NORMAL OPERATION. PAR. 21, 22, 23	✓	✓	✓	✓	✓	✓	✓

WEEKLY

NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, ~~SHOCK MOUNTS, ANTENNA MOUNTS,~~ COAXIAL TRANSMISSION LINES, ~~WAVE GUIDES,~~ AND CABLE CONNECTIONS. PAR. 14	Ⓧ	13	~~INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.~~	
8	INSPECT CASES, MOUNTINGS, ~~ANTENNAS, TOWERS,~~ AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 33	✓	14	~~CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES.~~	
9	INSPECT CORD, CABLE, WIRE, ~~AND SHOCK MOUNTS~~ FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. FIG. 8	✓	15	~~INSPECT METERS FOR DAMAGED GLASS AND CASES.~~	
10	~~INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.~~		16	~~INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHER-PROOFING.~~	
11	~~INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.~~		17	~~CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.~~	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ~~ELECTRICAL TRANSFORMERS, POWER STATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS,~~ AND PILOT LIGHT ASSEMBLIES. FIG. 17, 44	✓	18	~~CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.~~	

19 IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.

DA FORM 1 MAY 51 11-238 REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

TM5112-19

Figure 19. DA Form 11-238.

SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT

RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE: AZIMUTH AND RANGE INDICATOR IP-345/TPS-ID

EQUIPMENT SERIAL NO.: 000

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; Ⓧ Defect corrected.
NOTE: Strike out items not applicable.

NO.	ITEM	COND.	NO.	ITEM	COND.
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT ~~(spareheads, headphones, carrying cases, pins and cables, microphones, tubes, spare parts, technical manuals and accessories)~~. PAR. 9, 39, 40	✓	19	~~ELECTRON TUBES - INSPECT FOR LOOSE ENVELOPES, SAG BONNED SCRS, CRACKED SOCKETS, INSUFFICIENT SOCKET SPRING TENSION, CLEAN DUST AND DIRT CAREFULLY, CHECK EMISSION OF RECEIVER TYPE TUBES.~~	
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR. 11	✓	20	~~INSPECT FAIN CUT OUTS FOR LOOSE PARTS, DIRT, MISALIGNMENT AND CORROSION.~~	
3	~~CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, SWITCHES, HEWS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS.~~		21	INSPECT FIXED CAPACITORS FOR LEAKS, BULGES, AND DISCOLORATION. FIG. 46	✓
4	~~INSPECT SEATING OF READILY ACCESSIBLE "PLUG-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RECEPTORS.~~		22	~~INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR LOOSE MOUNTINGS, BURNED, PITTED, CORRODED CONTACTS; MISALIGNMENT OF CONTACTS AND ARMINGS; INSUFFICIENT SPRING TENSION; BINDING OF PLUNGERS AND WIRE PARTS.~~	
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. FIG. 17	Ⓧ	23	~~INSPECT VARIABLE CAPACITORS FOR DIRT, MOISTURE, MISALIGNMENT OF PLATES, AND LOOSE MOUNTINGS.~~	
6	CHECK FOR NORMAL OPERATION. PAR. 21, 22, 23	✓	24	INSPECT RESISTORS, ~~BUSHINGS, AND INSULATORS~~, FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION AND MOISTURE. FIG. 47, 48	✓
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ~~ANTENNA MOUNTS~~, COAXIAL TRANSMISSION LINES, ~~WAVE GUIDES~~, AND CABLE CONNECTIONS. PAR. 14	✓	25	INSPECT TERMINALS OF LARGE FIXED CAPACITORS AND RESISTORS FOR CORROSION, DIRT AND LOOSE CONTACTS. FIG. 46, 47, 48	Ⓧ
8	INSPECT CASES, MOUNTINGS, ~~ANTENNAE, TOWERS~~, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 36, 37	✓	26	CLEAN AND TIGHTEN SWITCHES, ~~TERMINAL BLOCKS~~, BLOWERS, ~~RELAY GASES~~, AND INTERIORS OF CHASSIS AND CABINETS NOT READILY ACCESSIBLE. FIG. 53	✓
9	INSPECT CORD, CABLE, WIRE, ~~AND SHOCK MOUNTS~~ FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. FIG. 8	✓	27	~~INSPECT TERMINAL BLOCKS FOR LOOSE OR WISTING, CRACKS AND BREAKS.~~	
10	~~INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.~~		28	~~CHECK SETTINGS OF ADJUSTABLE RELAYS.~~	
11	~~INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, FRAYS, AND FRAYING.~~		29	~~LUBRICATE EQUIPMENT IN ACCORDANCE WITH APPLICABLE DEPARTMENT OF THE ARMY LUBRICATION ORDER.~~	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES. FIG. 44, 49	✓	30	SELSYNS INSPECT ~~GENERATORS, AMPLIDYNES, DYNAMOTORS~~, FOR BRUSH WEAR, SPRING TENSION, ARCING, AND FITTING OF COMMUTATOR. FIG. 44	✓
13	~~INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.~~		31	CLEAN AND TIGHTEN CONNECTIONS AND MOUNTINGS FOR TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS. FIG. 45, 47, 48	✓
14	~~CLEAN AIR FILTERS, DRAG RANG PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES.~~		32	INSPECT TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS FOR OVERHEATING AND OIL-LEAKAGE. FIG. 45, 47, 48	✓
15	~~INSPECT METERS FOR DAMAGED GLASS AND CASES.~~		33	~~BEFORE SHIPPING OR STORING — REMOVE BATTERIES.~~	
16	~~INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.~~		34	INSPECT CATHODE RAY TUBES FOR BURNT SCREEN SPOTS. INSPECT YOKE FOR BINDING FIG. 44	✓
17	~~CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.~~		35	~~INSPECT BATTERIES FOR SHORTS AND DEAD CELLS.~~	
18	~~CHECK TERMINAL BOX COVERS FOR BRACING, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.~~		36	~~INSPECT FOR LEAKING WATERPROOF GASKETS, WORN OR LOOSE PARTS.~~	
			37	MOISTURE AND FUNGIPROOF. PAR. 36, 37	✓
38	IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.				

DA FORM 1 MAY 51 11-239 REPLACES DA AGO FORM ~~439~~, 1 DEC 50, WHICH IS OBSOLETE. 16—43113-1

TM5112-20

Figure 20. DA Form 11-239.

nance check list to be used by second and third echelon repairmen as directed by their commander.

c. Items not applicable to Azimuth and Range Indicator IP-345/TPS-1D are lined out on figures 19 and 20. References in the ITEM block are to paragraphs and figures in this manual which contain additional maintenance information pertinent to the particular item.

33. Performing Preventive Maintenance

Caution: Tighten screws, bolts, and nuts carefully. Fittings tightened beyond the pressure for which they are designed will be damaged or broken.

a. Exterior Items.

(1) Check for completeness (par. 6) and general condition of the remote ppi.

(2) Check the suitability of location and installation for normal operation (par. 11).

(3) Inspect the seating of the eight fuses on the rear panel (fig. 22) and inspect all plugs and connectors.

(4) Inspect all controls for binding, scraping, excessive looseness, misalignment, and positive action.

(5) Check for normal operation.

(6) Inspect the mounting base, the chassis and case assembly, and the cover for rust, corrosion, and moisture (par. 36 and 37).

(7) Inspect cords and cables for cuts, breaks, fraying, deterioration, kinks, and strain (fig. 8).

b. Internal Items.

(1) Inspect resistors, bushings, and insulators for cracks, blistering, discoloration, and moisture (fig. 47 and 48).

(2) Inspect and tighten mounting nuts and bolts of transformers and chokes (fig. 45).

(3) Inspect transformers for indications of overheating (fig. 45).

(4) Inspect wiring and interior cables for abrasion, frayed insulation, loose or broken cable lacing, loose cable clamps, and loose connections (fig. 8).

(5) Check moistureproofing and fungiproofing in areas where necessary (par. 36 and 37).

Section III. LUBRICATION AND WEATHERPROOFING

34. Lubrication Instructions for Azimuth and Range Indicator IP-345/TPS-1D

a. The type of lubricant to be used, the interval, and specific instructions for lubrication are given in figure 21.

b. Gasoline or carbon tetrachloride will not be used as a cleaning fluid for any purpose. When the unit is overhauled or repairs are made, clean the parts with Cleaning Compound.

c. Do not use excessive amounts of grease.

d. Be sure that lubricants and points to be lubricated are clean and free of sand, grit, or dirt. These abrasives are the chief cause of gear wear. Use Cleaning Compound to clean all parts. Wipe the parts dry with a lint-free cloth.

e. Do not lubricate the three ball bearings on which the deflection coil assembly rotates (fig. 44). The outer surface of these bearings should run dry and should be kept clean. Use Cleaning Compound to clean them. To prevent Cleaning Compound from entering the bearings, use only a cloth moistened with Cleaning Compound to clean them.

35. Parts Lubricated by Manufacturer That Do Not Require Subsequent Lubrication

Location	*Part lubricated*	*Lubricant used*	*Reason subsequent lubrication is not required*
Deflection coil gear train	Ball bearings (3)	Aircraft Instrument oil per MIL-L-6085A	Sealed bearings

36. Weatherproofing

a. General. Signal Corps equipment, when

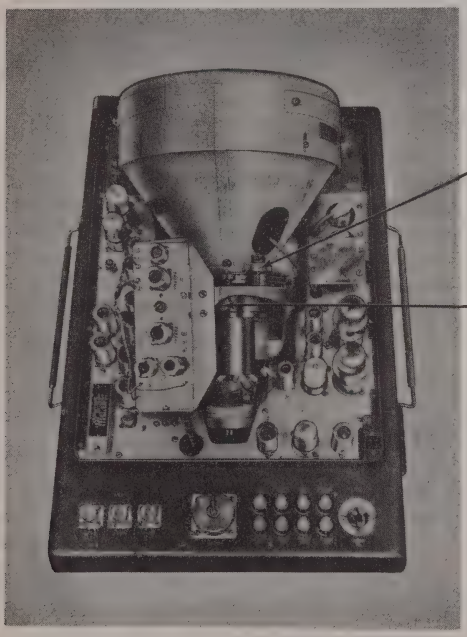
operated under severe climatic conditions, such as prevail in tropical, arctic, and desert regions, requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moisture, and extreme temperatures are harmful to most materials.

b. Tropical Maintenance. A special moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection. This treatment is explained in TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment, and TB SIG 72, Tropical Maintenance of Ground Signal Equipment. This remote ppi has not been given the moistureproof and fungiproof treatment at the factory but may be given this treatment when directed.

c. Winter Maintenance. Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely low temperatures are explained in TB SIG 66, Winter Maintenance of Signal Equipment, and TB SIG 219, Operation of Signal Equipment at Low Temperatures.

d. Desert Maintenance. Special precautions necessary to prevent equipment failure in areas

REMOVE COVER TO SERVICE



INTERVAL	LUBRICANT	EXPOSED GEARS
M	GL	CLEAN EXPOSED GEARS WITH CLEANING COMPOUND, BUTTER THE GEAR TOOTH SURFACES LIGHTLY.
		INCLOSED GEARS
S	GL	REMOVE BUTTON PLUG, APPLY TO GEAR TOOTH SURFACES WITH A SMALL SLIM TOOL. USE SPARINGLY.

NOTES:

1. CLEAN EXPOSED GEARS WITH A CLOTH MOISTENED WITH CLEANING COMPOUND. DRY THOROUGHLY WITH LINTLESS CLOTH.
2. KEEP LUBRICANT OFF ROLLING SURFACE OF BALL BEARINGS.
3. DO NOT PERMIT FOREIGN MATTER TO ENTER GEAR INCLOSURE.

KEY

LUBRICANT	INTERVAL
GL-GREASE, AIRCRAFT & INSTRUMENTS. ALL TEMPERATURES	M-MONTHLY
	S-SEMIANNUALLY

TM 5112-21

Figure 21. Lubrication Instructions for Azimuth and Range Indicator IP-345/TPS-1D.

subject to extremely high temperatures, low humidity, and excessive sand and dust are explained in TB SIG 75, Desert Maintenance of Ground Signal Equipment.

e. Lubrication. The effects of extreme cold and heat on materials and lubricants are explained in TB SIG 69, Lubrication of Ground Signal Equipment. Observe all precautions outlined in TB SIG 69.

37. Rustproofing and Painting

a. When the finish on the case or cover has been badly scarred or damaged, rust and corrosion can be prevented by touching up bared surfaces. Use #000 sandpaper to clean the surface down to the bare metal; obtain a bright smooth finish.

Caution: Do not use steel wool. Minute particles may enter the case and cause harmful internal shorting or grounding of circuits.

b. When a touch-up job is necessary, apply paint with a small brush. Remove rust from the case or cover by cleaning corroded metal with Cleaning Compound. In severe cases, it may be necessary to use Cleaning Compound to soften the rust and to use sandpaper to complete the preparation for painting. For further information on painting equipment, refer to TM 9-2851, Painting Instructions for Field Use.

Section IV. TROUBLE SHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

38. General

a. Trouble shooting at an organizational level is limited to the localizing of defective parts that are readily replaceable at an organizational level (tubes, fuses, cables, etc.). The procedures outlined are designed to determine first the defective part and then the nature of the fault. If the fault can be determined through organizational procedures, corrective measures or the need for repair at a field maintenance level is indicated. If the fault cannot be determined through organizational procedures, reference is made to the necessary field maintenance instructions.

b. The techniques used for organizational trouble shooting include visual inspection, operational tests, tube tests, and simple continuity checks. The material is presented in the order which the repairman would normally employ in servicing a defective remote ppi. When the procedures indicated are not sufficient to determine the source of trouble, trouble shooting at a field maintenance level will be required.

39. Fuse Location Chart

All fuses in the circuits of the remote ppi are located on a panel at the rear of the unit (fig. 22). Each fuse holder is provided with a normally off, blown-fuse indicator, which glows to indicate a blown fuse.

Ref symbol	*Rating (amp)*	*Circuit*
F601	4 (delay)	Primary power input
F602	4 (delay)	Primary power input
F603	.3 (delay)	Blower B601
F604	1.6 (delay)	Primary filament transformer T601
F605	2 (delay)	Primary plate transformer T602
F606	.5 (delay)	Primary high-voltage transformer T603
F607	1	Strip heater HR601 (when used)
F608	.8 (delay)	Synchro excitation and servo motor B603

40. Tube Location Drawing

Refer to figure 23 for the function, type, and location of each electron tube used in the remote ppi.

41. Tube Testing Techniques

When trouble occurs, check all cabling, connections, and the general condition of the equipment *before* attempting to remove the electron tubes. Isolate the trouble, if possible,

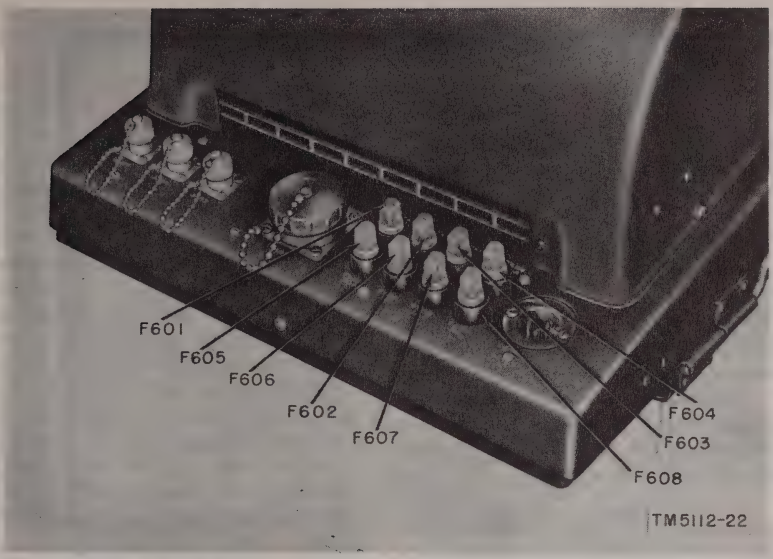


Figure 22. Azimuth and Range Indicator IP-345/TPS-1D, fuse locations.

to one of the following channels in the equipment: sweep and gate generator, marker generator, video amplifier, power supply, or servo amplifier. If tube failure is suspected test tubes with a tube tester and proceed as outlined in *b* below; if this procedure fails to clear the trouble, follow the procedure outlined in *b* or *c* below.

Caution: *Do not rock or rotate* the top of a minature tube when removing it from its socket; *pull it straight out.* Rocking or rotating the tube may cause the pins to bend and may break the weld where the pins enter the glass. A high-resistance or intermittent joint also may develop.

a. Using Tube Tester.

(1) Remove and test *one* tube at a time. If it is necessary to remove more than one tube at a time, label each one so that it can be replaced, if satisfactory, in its original socket.

(2) Replace a tube only when there is an obvious defect, such as a broken glass envelope, open filament, broken lead or connecting prong, or when a test in a tube tester or other equipment shows the tube to be defective.

(3) Do not discard a tube because it tests *on or near* the minimum test limit of the tube tester. Some new tubes test near the low end of the acceptability range of the tube specification. These tubes may provide satisfactory service over a long period of time, even though they remain at or near this low limit value.

(4) Do not discard a tube merely because it has been in use for a specified length of time. *Satisfactory operation in a circuit is the final proof of tube quality.*

b. Single Tube Substitution Method.

(1) Substitute a new tube for one of the suspected original tubes. If the remote ppi continues to be inoperative, replace the new tube with the original. Similarly, check each original tube suspected, one at a time, until the defective tube is located and the equipment becomes operative. Discard the last original tube removed from the equipment. DO NOT LEAVE A NEW TUBE IN A SOCKET IF THE EQUIPMENT OPERATES SATIS-

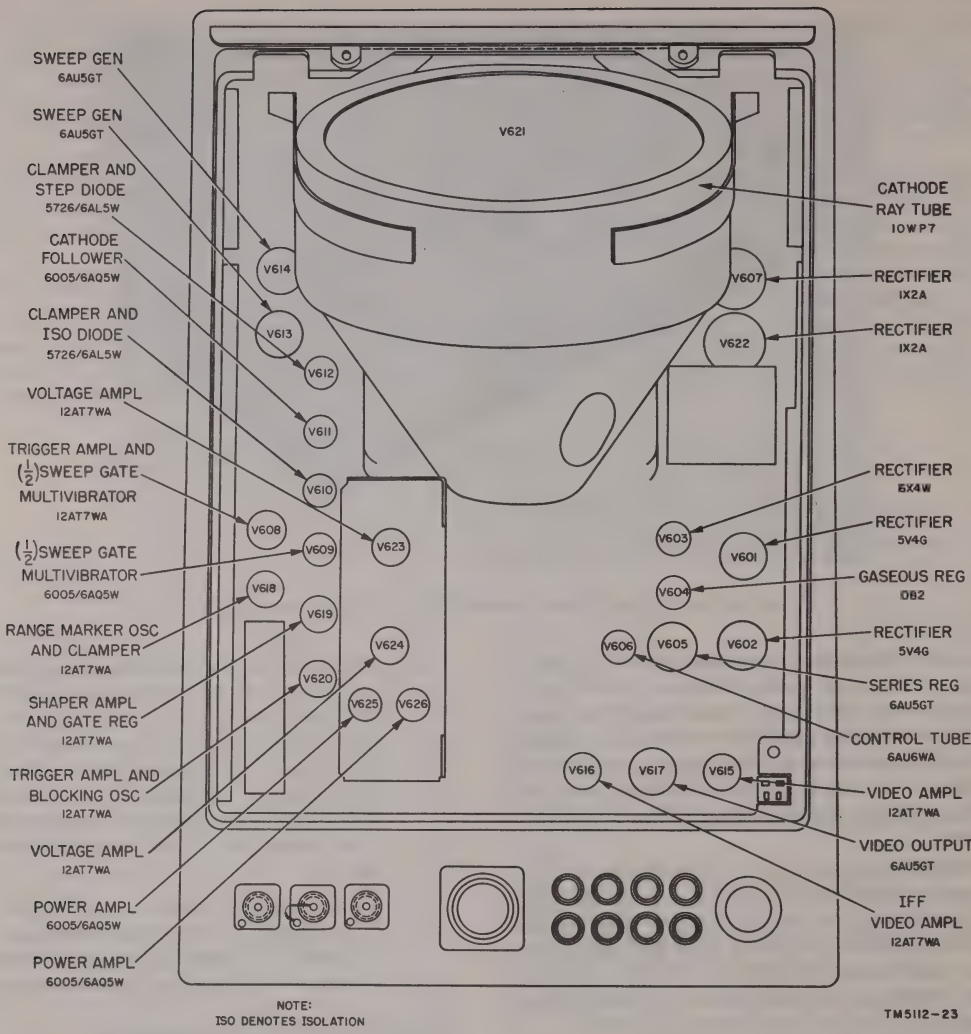


Figure 23. Azimuth and Range Indicator IP-345/TPS-1D, tube location drawing.

FACTORILY WITH THE ORIGINAL TUBE.

Note. Oscillator circuits (V618) and other circuits (V613 and V614) may function with one tube and not with another, even though both tubes are good. If practical, retain any removed tube until it is checked with suitable test equipment.

(2) If this method of tube substitution does not correct the trouble, try the method in *c* below.

c. Multitube Substitution Method. Occasionally, two or more tubes are defective in the remote ppi. In such cases, the procedure given in *b* above will not locate the trouble. Then install new tubes, one at a time, until the equipment becomes operative. Do this as follows:

(1) Remove one of the suspected original tubes. Install a new tube. If the equipment is still inoperative, leave the new tube in place and remove the next suspected original tube. Install another new tube. Mark the original tubes with the socket numbers from which they were removed. Continue this procedure until the remote ppi becomes operative. The last original tube removed is defective and, therefore, should be discarded.

(2) To determine whether another original tube is defective, return one of them to its original socket. If there is no noticeable difference in performance, leave the original tube in the equipment. In the same way, return the remaining original tubes to their sockets, one at a time. If equipment failure occurs, or performance suffers, discard the last original tube installed. DO NOT LEAVE A NEW TUBE IN A SOCKET IF THE EQUIPMENT OPERATES SATISFACTORILY WITH THE ORIGINAL TUBE.

d. Turn in for Repair. If none of the procedures outlined above restores the remote ppi to normal operation, *return the original tubes to their sockets* before forwarding the defective remote ppi to a higher echelon for repair.

42. Preferred Type Tubes

The following preferred type tubes are used in this remote ppi: 12AT7WA, 6005/6AQ5W, 5726/6AL5W, and 6 AU6WA. Use exact replacements.

43. Visual Inspection

a. Failure of the remote ppi to operate properly will usually be caused by one or more of the following faults:

(1) Faulty or missing trigger, video, or synchro data from master radar, because of fault in the master radar or fault in interconnecting cables.
(2) Blown fuses.
(3) Power source failure.
(4) Worn, broken, or disconnected power cable.
(5) Defective tubes.

b. When failure is encountered and the cause is not immediately apparent, check as many of the above items as is practicable before starting a detailed examination of the unit. Do not disassemble the unit without some knowledge of the operational symptoms. If possible, obtain information from the operator of the equipment regarding performance at the time trouble occurred.

44. Channel Sectionalization

Sectionalization of trouble to a channel consists of determining whether the trouble is in the gate and sweep generating channel, the range marker channel, the video amplifier, the antenna position indicating channel, or the power supply and control system.

a. Operate the remote ppi and observe its performance. Refer to the equipment performance check list (par. 46) for normal operating indications.

b. Check to see that the master radar is operating properly. If possible, check the performance of the master radar at another azimuth and range indicator.

c. Check for blown fuses at an early stage in trouble shooting. Each fuse has a blown-fuse indicator that glows when the fuse is open.

d. The absence of a sweep trace on the crt may indicate the absence of a trigger from the master radar, fault in the gate and sweep generating channel, or the power supply.

e. If the sweep trace appears normal but no targets are detected, the trouble may be in the master radar or the remote ppi video amplifier channel.

f. If range markers are absent, the trouble may be in the range marker channel.

g. If the sweep does not properly follow the movements of the antenna, the trouble may be in the antenna position indicating channel.

45. Trouble Shooting by Using Equipment Performance Check List

a. Purpose and Use. The equipment performance check list is the beginning of a systematic trouble-shooting technique to isolate trouble with a minimum of waste effort. Operate the equipment as directed in the check list and check for normal indications listed; if an abnormal indication is obtained, follow the corrective measure outlined in the final column of the check list.

b. Corrective Measures. In a few cases, the nature of the possible abnormal indications permits immediate localization of trouble to a particular part, so that the corrective measure indicates the specific part to be repaired or replaced. In most cases, however, the possible abnormal indications provide only for sectionalization of the trouble to a stage or group of stages. In these latter cases, the corrective measures call for the performance of additional testing procedures in order to localize the trouble. When the procedure referred to is beyond the scope of organizational maintenance personnel, trouble shooting at a field maintenance level is required.

46. Equipment Performance Check List

	Item No.	*Item*	*Action or condition*	*Normal indication*	*Corrective measures*
PREPARATORY	1	POWER-OFF switch	Set at OFF.		
	2	Cabling	All connections properly made (fig. 8).		
	3	INT control	Turn to maximum counterclockwise position.		
	4	MARKERS control	Turn to maximum counterclockwise position.		
	5	VIDEO GAIN control	Turn to maximum counterclockwise position.		
	6	IFF VIDEO GAIN control	Turn to maximum counterclockwise position.		
	7	DIMMER control	Turn to maximum counterclockwise position.		
	8	RANGE control	Turn to 20.		
	9	Master radar	Turn on and check for normal operation.		
EQUIPMENT PERFORMANCE	10	POWER-OFF switch	Turn to the POWER position, then listen carefully.	Blower motor in cover starts running.	Check fuses F601, F602, and F603.
					Inspect J601 and P601 and their connections.
				Relay K601 pulls in approximately 10 seconds after POWER-OFF switch is turned on. Relay makes a barely audible click.	Check fuse F605 and interlock S603. Check V603 and V604.
	11	INT control	Advance slowly clockwise.	Normal sweep appears on cathode-ray tube.	Check for trigger input from master radar at J603. Check fuses F604 and F606.

	Item No.	Item	Action or condition	Normal indication	Corrective measures
EQUIPMENT PERFORMANCE					Check to see that relay K601 is closed. Check electron tubes V601 through V614, V621, and V622. Trouble shooting by field maintenance personnel is required. Refer to chapter 6.
				Sweep follows rotation of the antenna.	Check fuse F608. Check servo gain adjustment (par. 17). Check electron tubes V623 through V626.
	12	MARKERS control	Advance slowly clockwise.	Markers appear on cathode-ray tube.	Check for proper jumper connections (par. 17). Check electron tubes V618, V619, and V620.
				Two 10-mile markers or four 10,000-yard markers displayed, depending upon position of marker jumpers (par. 17).	Make proper sweep step and sweep slope adjustments (par. 17).
	13	RANGE control	Turn to 40 position.	Four 10-mile markers or eight 10,000-yard markers displayed.	Check sweep step and slope adjustments (par. 17).
			Turn to 80 position.	Eight 10-mile markers or three 50,000-yard markers displayed.	Check sweep step and slope adjustments (par. 17).
			Turn to 160 position.	Sixteen 10-mile markers or six 50,000-yard markers displayed.	Check sweep step and slope adjustments (par. 17).
	14	VIDEO GAIN control	Advance control clockwise.	Target echoes or ground clutter appears on cathode-ray tube.	If crt screen sparkles but no clutter or echoes are displayed: check master radar for normal operation. Check video coaxial cable W2 and connections. If neither sparkle or clutter is displayed on crt check electron tubes V615, V616, and V617. Trouble shooting by field maintenance personnel is required.
	15	IFF VIDEO GAIN control	Advance control clockwise.	Iff video displayed on cathode-ray tube.	Check iff video coaxial cable W3 and connections. Check iff equipment for normal operation.

	Item No.	Item	Action or condition	Normal indication	Corrective measures
EQUIPMENT PERFORMANCE	16	DIMMER control	Turn in clockwise direction.	Cursor lines glow red and increase in brightness. Azimuth scale glows amber and increases in brightness.	Check lamps I 602 and I 603. Check J601, P601, and connections. Check wiring inside cover assembly. Check dimmer potentiometer R1624.
	17	INT control	Turn to full counter-clockwise position.		
STOP	18	MARKERS control	Turn to full counter-clockwise position.		
	19	POWER-OFF switch	Turn to OFF. *Note.* Unplug power cable to remove power from heater HR601.		

CHAPTER 5
THEORY OF AZIMUTH AND RANGE INDICATOR IP-345/TPS-1D

Section I. INTRODUCTION

47. Block Diagram

Figure 58 is a block diagram of Azimuth and Range Indicator IP-345/TPS-1D. The gate and sweep generating channel consists of CR601, V608 through V614 and V619B. The marker generator channel consists of V618, V619A, and V620. The video amplifier channel consists of CR602 and V615, V616, and V617. The deflection coil yoke servo amplifier consists of V623, V624, and V625. For a complete schematic diagram, refer to figure 59. Figure 24 shows the timing relationships in the gate and sweep generating channels.

48. Over-all System Operation

a. Sweep Gate and Generator Channel. A positive trigger from the master radar (A, fig. 24) is fed through crystal diode limiter CR601 to the grid of V608. The amplified and inverted trigger from V608A triggers the sweep gate multivibrator (V608B and V609), which produces a positive rectangular wave for gating the sweep generator. The positive gate (B, fig. 24) is applied through cathode follower V611 to the screen grids of sweep generators V613 and V614 with clamper V610B maintaining the correct and constant direct-current (dc) relationships at the grid of V611. Sweep generators V613 and V614 generate a trapezoidal voltage wave (D, fig. 24) for application to the deflection coil. A rectangular wave supplied through isolation diode V610A and step diode V612B to the control grids of V613 and V614, helps to regulate the step at the initial portion of the trapezoid. Gate regulator V619B couples a rectangular wave from V611 output back to V611 input to improve the rectangular wave gate characteristics.

b. Range Marker Channel. A negative rectangular wave (C, fig. 24) from the sweep gate multivibrator is applied to gated clamper V618A to turn on marker oscillator V618B. The output of V618B is shaped and amplified by V619A and passed along to trigger tube V620A, which furnishes a trigger for blocking oscillator V620B. The steep-sided markers generated in V620B are applied to grid 1 of the cathode-ray tube to display the markers.

c. Video Amplifier and Crt Circuit.

(1) Video signals from the master radar are applied to video amplifier V615A. Video signals from the iff set are applied to iff video amplifier V616A. These video signals are mixed in the common plate circuit. The mixed video is applied to V615B where it is inverted and amplified and passed on to video output tube V617. Clamper diode CR602 maintains the correct and constant dc relationship at the grid of V617. An unblanking gate is applied to the screen of V617 from V611. The amplified and mixed video is applied to the crt cathode to intensity modulate the electron beam.

(2) The high-voltage power supply applies +8,500 volts to the voltage-divider network to furnish the proper dc potentials for the cathode-ray tube elements. The focus adjustment potentiometer is included in this voltage-divider network. The intensity voltage

divider is connected to the —300-volt and +150-volt supplies. This divider produces the required dc voltage for crt grid 1. The INT control potentiometer is a part of this divider network.

d. Antenna Position Indicating System. Single speed antenna position data from the master radar is applied to the stator windings of synchro control transformer B602. The error voltage from the rotor of B602 is applied through stabilizing network Z604 to amplifier V623A. The stabilizing network improves the sensitivity of the servo amplifier to changes in tracking rate. Voltage amplifiers V623B and V624A follow the input stage, and paraphase amplifier V624B provides the drive for power amplifiers V625 and V626. The output from the power amplifiers is applied to servo motor B603. The 115-volt, 60-cycle reference voltage for the servo motor and the synchro transmitter in the master radar is supplied from the primary power circuits of the remote ppi. The servo motor drives the deflection coil yoke in synchronism with the master radar antenna.

e. Power Supplies. Direct-current voltages for operating the electron tubes are supplied by three rectifier power supplies.

(1) High voltage at +8,500 volts for operation of the cathode-ray tube is furnished by a power supply that uses two 1X2A half-wave rectifiers, V607 and V622.

(2) Positive dc voltages are obtained from a power supply that uses full-wave rectifiers V601 and V602 and an electronic voltage-regulating circuit consisting of V605 and V606. This power supply provides +250 volts regulated and +150 and +360 volts unregulated.

(3) Negative voltages at —300 volts unregulated and —108 volts regulated by a gaseous regulator tube are furnished by the third power supply. The rectifier tube is V603 and the gaseous regulator is V604.

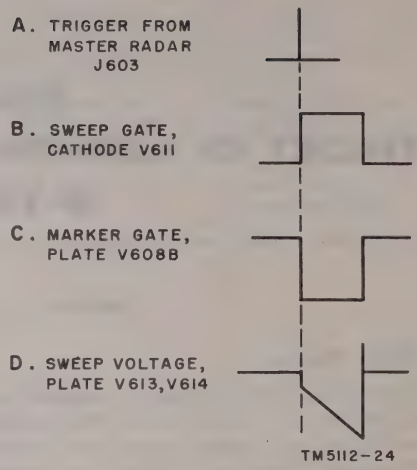


Figure 24. Gate and sweep time relationship.

Section II. GATE AND SWEEP GENERATING CHANNEL

49. Trigger Amplifier and Sweep Gate Multivibrator

(fig. 25)

a. Trigger Amplifier V608A. A positive trigger of not less than 5 nor more than 50 peak volts amplitude is supplied from the master radar over a 75-ohm coaxial cable. Resistor R610 provides the proper termination for this cable. This trigger is limited to approximately 4½ volts by the action of crystal diode limiter CR601. During the absence of signal input, V608A is held at cutoff by the voltage divider composed of R612 and R613, which applies a positive bias on the cathode. The control grid is held at less than ½ volt, because of the connection to ground through crystal diode CR601 and resistor R610. Upon the application of a positive trigger to the cathode of CR601, the crystal diode is cut off at the initial ½-volt rise of the trigger voltage. Because the grid is returned to the cathode through R611, cutting off CR601 immediately raises the grid voltage of V608A to that of the cathode and the tube starts conducting. The resultant drop in V608A plate voltage is coupled over to the sweep gate multivibrator through plate coupling capacitor C611. Resistor R614 is the plate load resistor and

C610 is the cathode bypass capacitor.

b. Sweep Gate Multivibrator. The sweep gate multivibrator, which consists of V608B and V609, is a monostable multivibrator. In the at-rest state, V609 conducts heavily and draws screen current through screen resistor R625. This lowers the screen potential and establishes the dc voltages in the voltage-divider network of R623 and R624. This network places the grid of V608B at approximately —45 volts, which holds the tube at cutoff. The negative trigger from V608A, applied through C611 and C612 to the control grid of V609, cuts off V609 and starts the screen voltage rising toward the divider voltage established by R623, R624, and R625. The grid of V608B rises because it is coupled to V609 screen through the network of R624 and C613. This causes the plate voltage of V608B to drop rapidly. The drop in V608B plate voltage is coupled through C612 to the control grid of V609, maintaining the cutoff condition of V609 for a period determined by the time constant of C612 and the timing resistance selected by the RANGE switch S604. When S604 is in the 160 position, the timing resistance consists of resistors R620, R621, and R622. Resistor R621 is a potentiometer by which the maximum (160-mile) gate length is adjusted. When conduction resumes in V609, the original at-rest conditions of the multivibrator are restored. Resistors R615, R616, and R617 comprise the plate load of V608B, which is divided to furnish a negative gate of approximately 100-volt amplitude to the marker channel. Resistors R626 and R1607 and inductor L603 comprise the plate load impedance of V609. The use of L603 permits a high signal impedance without excessive dc voltage drop in the plate circuit of V609. The positive rectangular gate developed in the plate circuit of V609 is coupled over to cathode follower V611.

50. Sweep Gate Cathode Follower

(fig. 26)

a. Clamper V610B. The positive rectangular gate from the sweep gate multivibrator is coupled through coupling capacitor C614 and applied to the control grid of cathode follower V611. Because of the long time duration of the rectangular gate and the consequent necessary large value of coupling capacitor C614, clamper V610B is used to maintain V611 control grid at the proper dc level. This clamper diode prevents a residual charge from building up across C614 caused by the long time constant of the V611 input circuit.

b. Cathode Follower V611. Cathode follower V611, which acts as a low-impedance power amplifier, supplies a positive rectangular wave of approximately +170-volt amplitude. Resistor R628 is the grid resistor across which the input signal is developed. Resistors R627 and R629 comprise the voltage-divider network that supplies approximately —85 volts to V611 control grid. Cathode follower V611 furnishes a rectangular wave for the following purposes:

(1) To feed back through V619B for improving the characteristics of the input wave.

(2) To turn on sweep generating tubes V613 and V614 for generating the sweep voltage.

(3) To gate video amplifier V617 for unblanking the cathode-ray tube.

c. Gate Regulator V619B. To improve the characteristics of the rectangular wave applied to V611 grid, a negative gate is fed back through gate regulator V619B. During the absence of signal, this tube is held well below cutoff by the application of approximately —75 volts grid bias developed in the voltage-divider network that consists of R1613, R1614, R632, and diode V612A. The positive rectangular wave from V611 cathode is applied to V619B grid where it overcomes the bias and drives the tube into conduction. The resultant drop in plate voltage prevents the plate of V609 from rising to the supply voltage and effectively flattens out the top of the rectangular wave at the multivibrator (V609) plate. This improvement in the gating rectangular wave helps to prevent undesirable variation in intensity along the sweep trace. Variable capacitor C651 provides compensation for the effect of interelectrode and stray lead capacity on the phase of the feed-back wave. Capacitor C650 adds to the stray and interelectrode capacity, thus permitting the capacitance of C651 to be within a practical range.

d. Gate Clamper V612A. Clamper diode V612A operates to maintain the required dc level at V611 cathode and the screens of V617, V613, and V614. The no-signal voltage at V612A cathode is approximately —5 volts and at V611

cathode approximately —25 volts. These voltages are maintained by the voltage-divider network of R1615, R1616, R630, R632, and V612A (fig. 26 and 27). Because the plate of V612A is connected to ground, this tube prevents the voltage at V611 cathode from dropping below the divider level (approximately —25 volts).

51. Sweep Generator

(fig. 27)

a. The sweep generator provides the deflection coil with a current wave form, which increases linearly with time. The voltage wave form required to produce the desired linear rise in the deflection coil current is a negative step voltage plus a linear sawtooth. The linearity of the current rise in the deflection coil depends primarily on obtaining the proper ratio of step to sawtooth in the voltage wave form. On the shorter ranges, a higher ratio of step to sawtooth voltages is necessary.

b. Prior to the sweep starting time, the screens of sweep generator tubes V613 and V614 are held at approximately —25 volts by the voltage-divider network that determines V611 cathode voltage. The control grids of V613

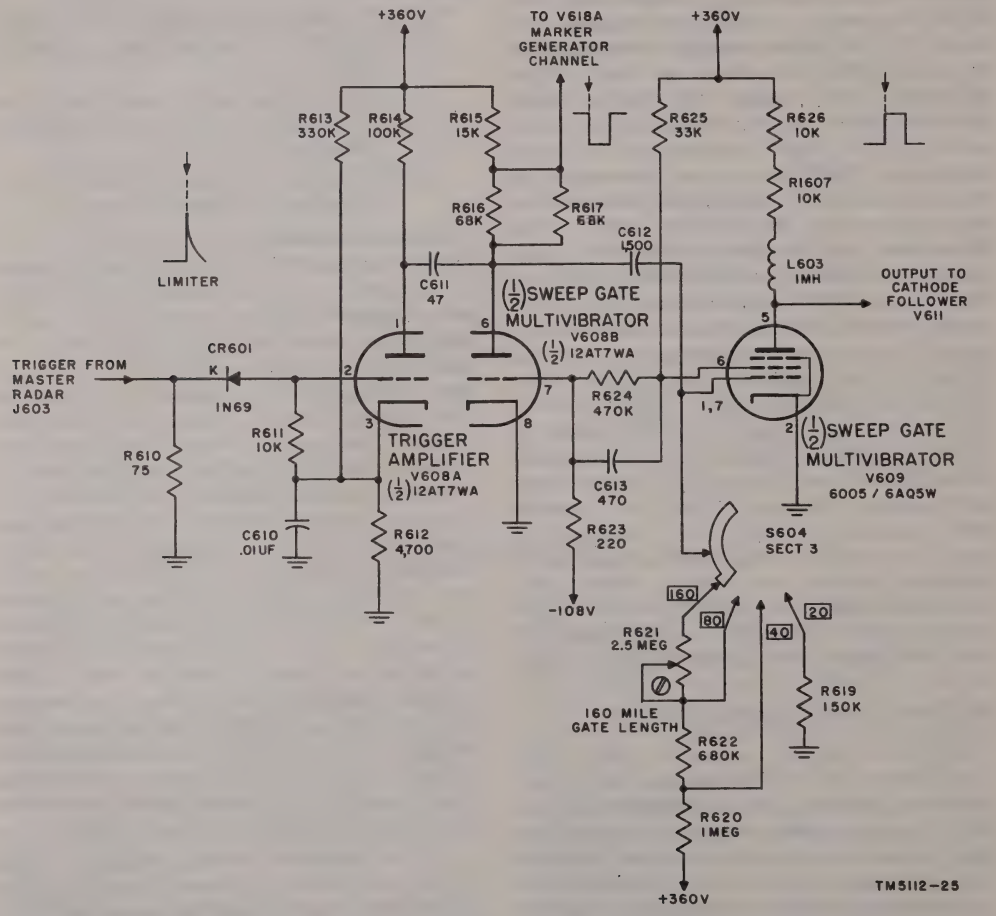


Figure 25. Trigger amplifier and sweep gate multivibrator, simplified schematic diagram.

and V614 are held at approximately —28 volts by the action of R1618, R1619, R631, R1617, and the conduction of step diode V612B through R636, R637, R1604, and R1605. The combination of these two biases is sufficient to hold the sweep generators at cutoff. Because the sweep generator tubes are cut off, C619 is charged with 360 volts on the plate side and —28 volts on the grid side. Upon application of the 170-volt rectangular gate to the screens of V613 and V614, these tubes start to draw plate current. The initial rise in plate current causes a voltage drop across the plate load impedance consisting of R646, the deflection coil, and its shunting resistors. Resistor R647 is included on all other ranges. Because C619 cannot change charge instantaneously, this negative going voltage is fed back to the grids of V613 and V614 through C619, R643, and C643. This negative voltage coupled back to the grid will momentarily prevent a further increase in the tube current. This occurs within ½ microsecond after the screens of V613 and V614 are gated on and accounts for the initial negative spike shown on the grid wave form.

c. At the same time, the positive gate from V611 cathode is applied to the plate of isolation diode V610A causing V610A to conduct and to raise the cathode potential of step diode V612B, cutting that tube off. When step diode V612B is cut off, the voltage at the control grids of the sweep generators would tend to rise in a positive direction, if no other factors were involved. However, as the grid voltage tends to rise in a positive direction toward the voltage-divider action of R1604 and R1605, the increase in current through the tube will cause a decrease in plate voltage. The negative going plate voltage will be coupled through C1619, C643, and R643 to the grids and will tend to oppose the rise in

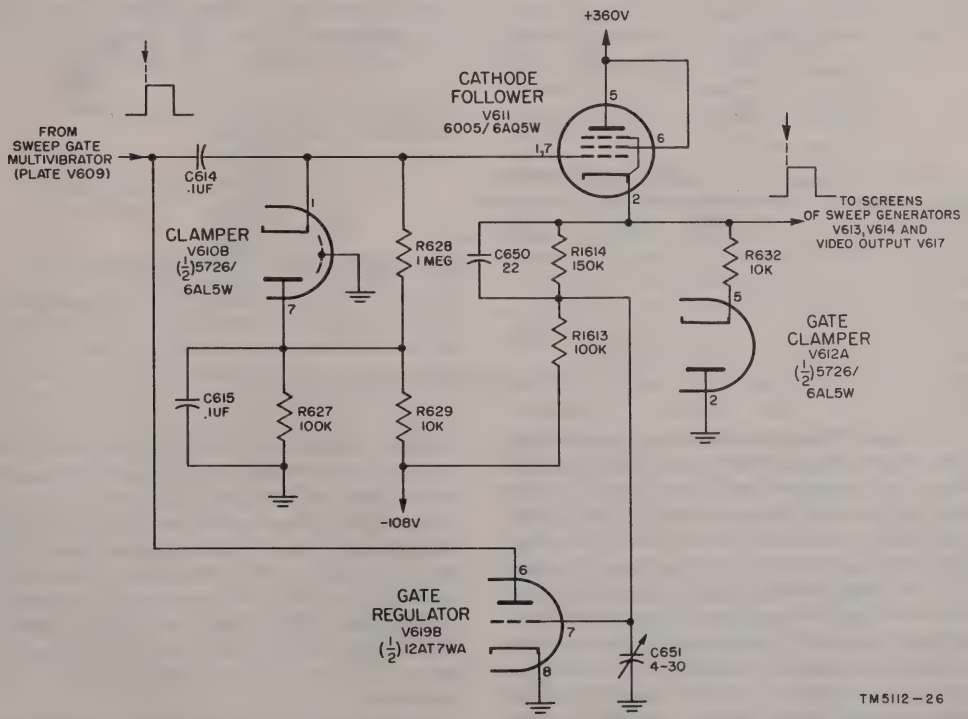


Figure 26. Sweep gate cathode follower, simplified schematic diagram.

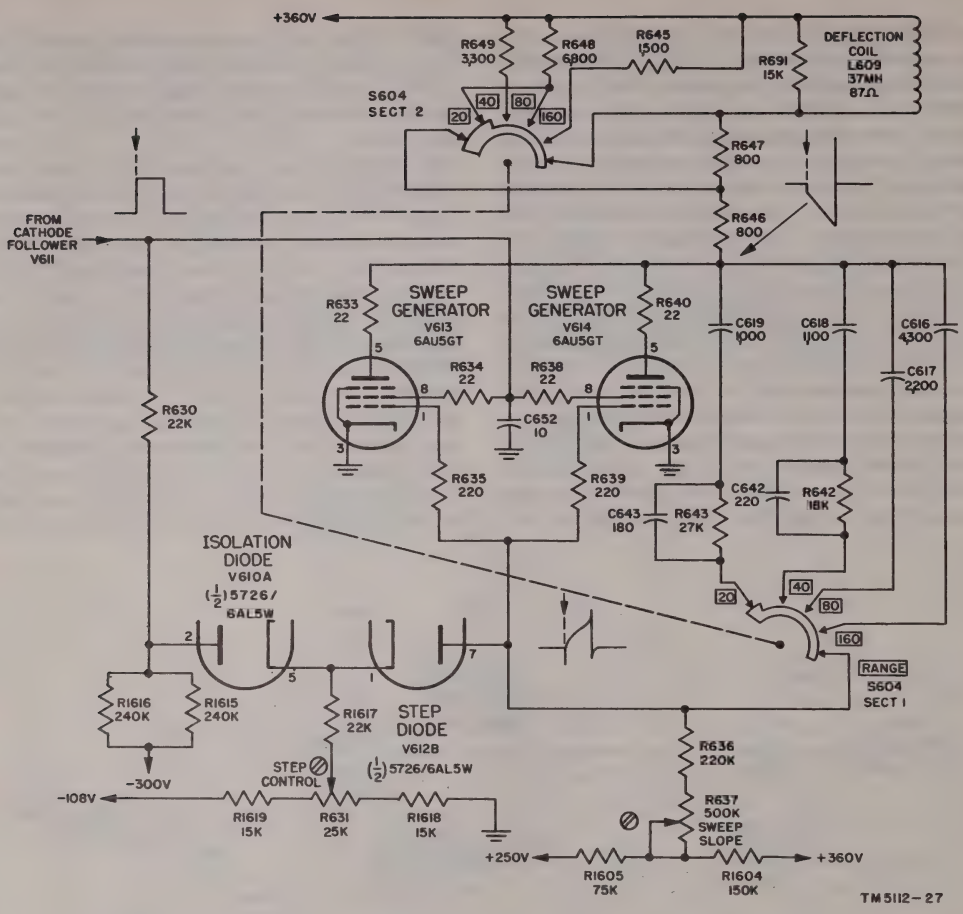


Figure 27. Sweep generator, simplified schematic diagram.

grid voltage. This action results in a linear drop in the plate voltage of V613 and V614. The slope of the grid voltage rise is determined by the time constant of RC circuit R1604, R1605, R637, R636, R643, C643, and C619. This slope and the operating characteristic of the tubes combine to give a voltage wave form the step and sawtooth of which give the desired current rise in the deflection coil. At the end of the sweep gate, the positive voltage is removed from the screen grids of V613 and V614 and from the plate of isolation diode V610A. This places the negative voltages on the screen and control grids again as step diode V612B will now conduct. These negative voltages on the grids of the sweep generator tubes will cut off V613 and V614 until the positive gate is again applied. The sharp positive spike on the grid voltage wave at the end of the linear rise is caused by a spike differentiated from the trailing edge of the gate fed back through C619, R643, and C643. Resistors R633, R634, R635, R638, R639, R640, and capacitor C652 are for suppressing transients and parasitics.

d. The actual amplitude of the negative step on the voltage wave form on V613 and V614

plate depends upon the amount of feed-back voltage from the plate circuit to the grid circuit and the no-signal dc level of V613 and V614 grids. These factors are regulated by plate load resistors R646 and R647, R643 in the feed-back path, and the step-control divider network. At the 20-mile range where a greater step is required, the feed-back voltage is reduced by tapping down on plate load resistors R646 and R647 and inserting R643 in the feed-back circuit. At the 40-mile range where the step must be smaller, the plate load is larger and less resistance is used (R642) in the feed-back circuit. At the 80- and 160-mile ranges, no resistance is used in the feed-back circuit. The feed-back voltage can drive sweep generators V613 and V614 only to near cutoff; therefore, the amount of the step can be adjusted by changing the no-signal dc level of their control grids. Step control R631 in divider network consisting of R1618, R631, and R619 adjusts the voltage distribution along divider consisting of R1618, R631, R1619, R1617, V612B, R636, R637, R1604, and R1605 to determine the dc level on V613 and V614 grids. This level determines the change in grid voltage necessary to drive V613 and V614 at nearly cutoff. The additional voltage-divider section consisting of R1615, R1616, and R630 is necessary to hold the plate of isolation diode V610A at approximately —70 volts under no-signal conditions. This holds V610A at cutoff and permits the step diode to operate at the required level (approximately —28 volts).

e. The ratio of the step portion to the sawtooth portion of the sweep voltage wave form is modified by R691 and the other shunting resistance switched in by section 2 of S604. If there were no resistance across deflection coil L609, the entire step would appear across the coil and virtually none across plate load resistors R646 and R647 because of the high resistance of the coil to the steep-sided signal. With shunting resistors R691, R645, R648, and R649 across L609, the correct proportion of step to sawtooth for the different ranges is obtained. These shunt resistors provide rapid damping of L609 and therefore prevent oscillatory overshoots from occurring at the end of the sweep gate period. Such overshoots, at the 160-mile range particularly, would produce erratic sweeps because of the limited recovery time between successive sweep periods.

Section III. RANGE MARKER CHANNEL

52. Range Marker Clamper and Oscillator

(fig. 28)

a. When turned on by a rectangular gate from the sweep gate multivibrator, the range marker oscillator produces a series of regularly spaced pulses for use as range markers on the cathode-ray tube. By means of a jumper board (par. 17*d*), range markers at 10-mile intervals or at 10,000- and 50,000-yard intervals can be selected. Range markers are selected by the use of separate tuned circuits, Z601, Z602, and Z603 (fig. 59), the resonant frequency of which corresponds to that required for the specific marker period. The oscillator tube, when connected to the selected tuned circuit, comprises a basic Hartley oscillator stage. For simplicity, only Z601 and the connection for the 20- and 40-mile sections of S604 are shown in figure 28.

b. Because of the B+ grid return, clamper V618A, in the absence of signal, is in a conducting state with the space current flowing through the coil of the tuned circuit (Z601). Grid current is limited by the use of a high resistance (R666) in series with the positive grid return. The low impedance of V618A when in a conducting state loads the selected tuned circuit (Z601) and lowers the effective Q so that oscillation is impossible.

c. A negative gate from sweep gate multivibrator V608B of approximately 100 volts amplitude is applied to the grid of V618A through coupling capacitor C630. This cuts off V618A and removes the load from the tuned circuit (Z601). The collapsing field in the tuned circuit coil produces a negative increment on the cathode of V618A and grid of V618B. Because range marker oscillators V618B and Z601 are connected to form a Hartley oscillator circuit, the stage will oscillate. Oscillation will continue, at a frequency determined by the circuit constants, until the end of the gating period when clamper V618A again conducts and prevents oscillation. The phasing of the oscillations at each gating period is uniform because the

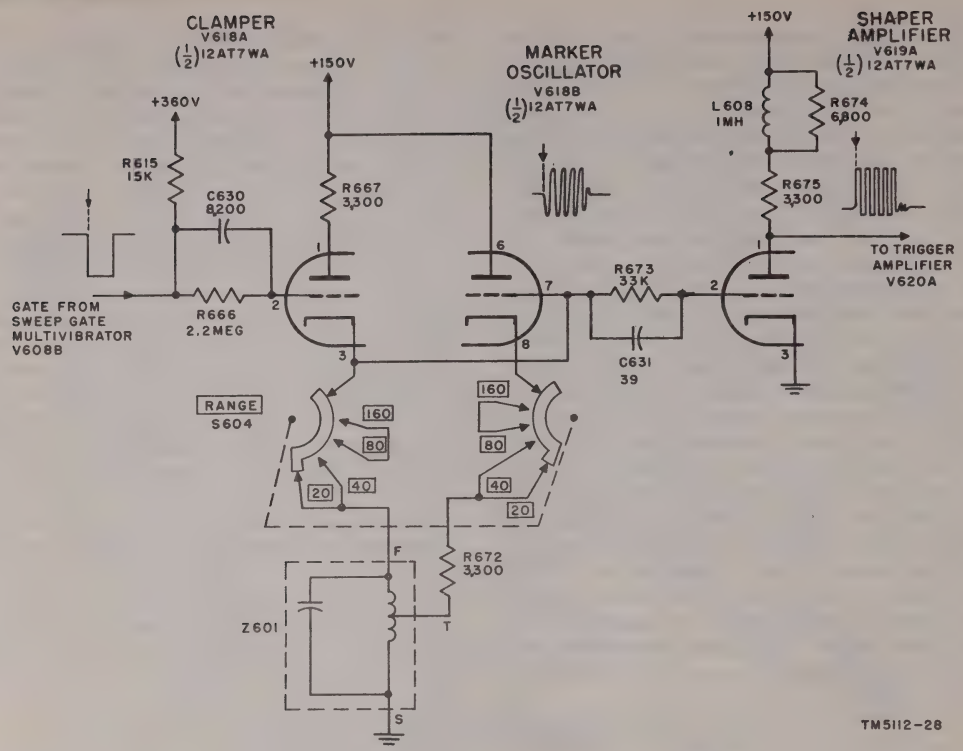


Figure 28. Marker oscillator and shaper amplifier, simplified schematic diagram.

increment of a cycle that initiates each oscillation period is of the same polarity.

d. Resistor R667 in V618A plate circuit helps to limit the plate current during no-signal periods. Resistor R672 is the V618B grid bias resistor.

53. Shaper Amplifier

a. The output of the gated oscillator is coupled directly to the grid of shaper amplifier V619A through phase-correction circuit R673 and C631. V619A operates as a self-biased amplifier with approximately +130 volts on the plate and is driven by a signal of approximately 70 volts amplitude (peak to peak). This results in grid-current limiting on the positive half-cycle of the grid signal and cutoff limiting on the negative half-cycles. Thus, the output wave of V619A is squared up.

b. The plate load impedance of V619A consists of R674, R675, and L608. This impedance load furnishes adequate signal amplitude without excessive direction-current voltage drop.

54. Trigger Amplifier and Range Marker Blocking Oscillator

a. The squared-off markers are applied to the grid of trigger amplifier V620A through coupling capacitor C632 (fig. 29). These signals are developed across grid resistor R676. Trigger amplifier V620A operates at nearly cutoff with bias supplied by cathode-biasing resistor R1606, which is bypassed by C647. This tube is inductively coupled through T604 to blocking oscillator V620B, which generates the steep-sided markers.

b. The positive half-cycles of the signals from V619A plate circuit cause a rise in V620A plate

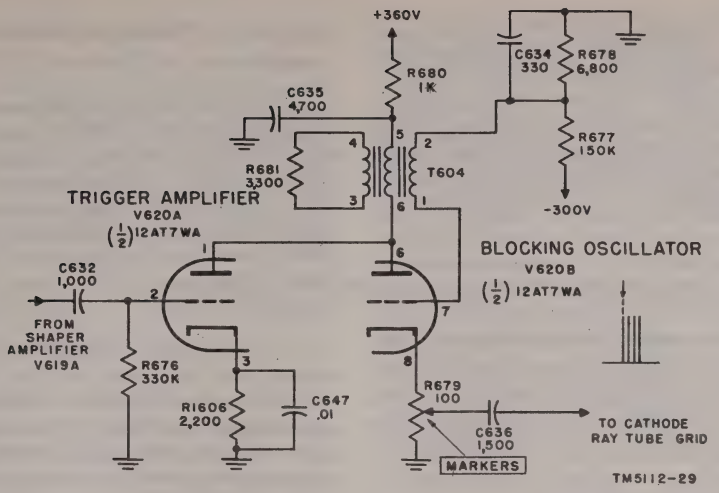


Figure 29. Trigger amplifier and blocking oscillator, simplified schematic diagram.

current that brings about a rising current through winding 5-6 (primary) of transformer T604. This induces a voltage in the secondary of the transformer (terminals 1 and 2) that drives normally cutoff V620B into conduction. As the full conduction of V620A and V620B is approached, the *rate of change* of plate current decreases and the voltage induced in the secondary decreases, therefore lowering the V620B grid voltage. This results in a further decrease in plate current. Blocking oscillator V620B is driven sharply into cutoff and produces a very steep-sided wave form. Once conduction of V620B has ceased, the tube is held below cutoff by approximately —15 volts grid bias developed in divider network consisting of R677 and R678. Capacitor C634 bypasses resistor R678 to ground, therefore maintaining the lower end of transformer T604 secondary at signal ground potential while permitting the desired dc biasing level to be maintained. Resistor R680 and capacitor C635 comprise a decoupling network to prevent the transients developed in this circuit from being carried back through the positive dc supply. Resistor R681 places a load across the tertiary winding of T604 to help damp out objectionable overshoots. The markers are taken off across cathode load resistor R679 and applied to the crt grid through coupling capacitor C636. Resistor R679 is a variable resistance to facilitate selection of the desired marker amplitude applied to the crt. This resistor (R679) is the MARKERS intensity control.

Section IV. VIDEO AMPLIFIER CHANNEL

55. Video Amplifier and Iff Video Amplifier

(fig. 30)

a. Video signals supplied by the master radar are connected through J604 to the input circuit of video amplifier V615A. Resistors R650 and R651 comprise the terminating resistance for the 75-ohm coaxial cable from the master radar. Potentiometer R651 is used to adjust the level of signals applied to the video amplifier and therefore the intensity of the video display on the cathode-ray tube. Video signals are applied to the grid of V615A through coupling capacitor C622 and are developed across grid resistor R652. These signals are inverted and amplified by V615A and are passed on to video amplifier V615B. Video amplifier V615A operates with the grid at ground potential and approximately

1 volt cathode bias developed across R653. Capacitor C644 is the cathode resistor bypass capacitor. A decoupling network, consisting of R696, R695, R698, C603, and C645, prevents video frequencies from entering the power supply and prevents oscillations in the video amplifier channel that may otherwise be caused by an impedance common to two or more stages of amplification.

b. Video signals from iff equipment are applied to iff video amplifier V616A through coupling capacitor C665. Resistors R1620 and R1621 furnish proper termination for the coaxial cable and R1621 is used to adjust the amplitude of iff video signals applied to the video amplifier channel. Resistor R1622 is the grid resistor and R1623 is the cathode-biasing resistor.

c. Tubes V615A and V616A have a common plate load across which the amplified radar and iff video signals appear. These signals are mixed and applied to the grid of video amplifier V615B.

56. Video Amplifier and Output Tube (fig. 31)

a. The mixed video signal is coupled through coupling capacitor C624 to the grid of video amplifier V615B where it is amplified and inverted. Resistor R656 is the grid resistor and R699 is the cathode-biasing resistor that is bypassed by capacitor C646. Output voltage appears across plate load resistor R657. Resistors R1601, R1602, and R1603, together with C625 and C626, comprise the plate decoupling filter.

b. Capacitor C627 couples the positive video signals from the plate circuit of V615B to the grid of video output V617. To handle the large signal input, this tube is operated with —17 volts grid bias developed by divider network consisting of R658 and R660. R661 is the grid resistor and C629 bypasses voltage-divider resistor R658. Because of the comparatively large value of C627 and the resulting long time constant in V617 grid circuit, crystal diode clamper

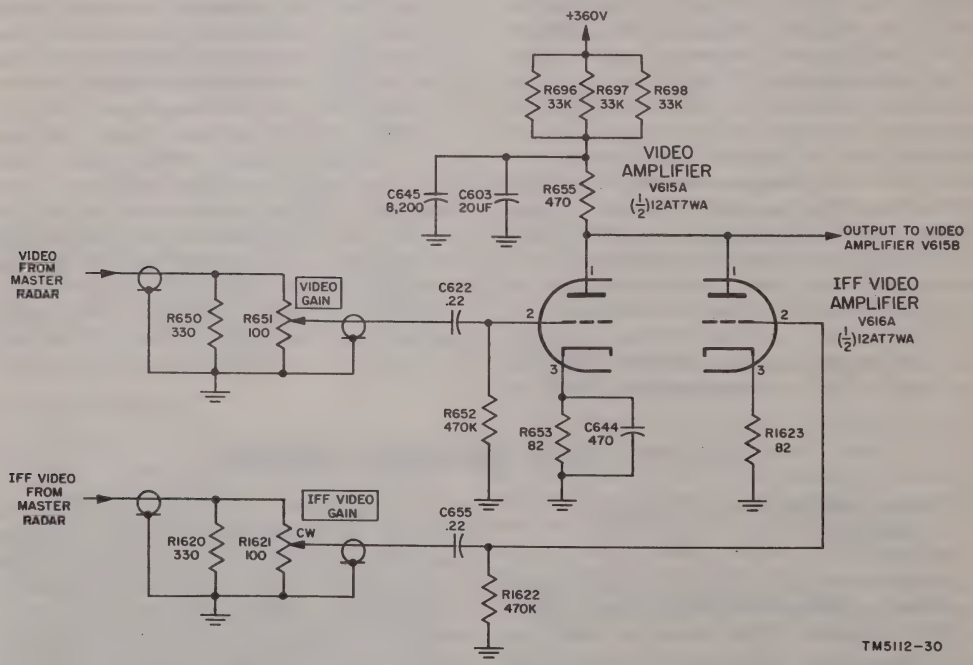


Figure 30. Video amplifier and iff video amplifier, simplified schematic diagram.

CR602 is used to help maintain the grid at a constant dc level. The amplified video appears in the plate circuit of V617 as negative-going signals and are directly coupled to the cathode of the cathode-ray tube where they intensity modulate the electron beam. During the intervals between gate periods, the screen of V617 is held at approximately —25 volts, by the divider network that determines V611 cathode voltage (par. 50), and the tube is thereby held at cutoff. This causes the cathode of the crt to be held at the V617 B+ supply voltage, thus blanking the tube. Upon application of the +170-volt gate to V617 screen, conduction starts in the tube, therefore passing the amplified video signals on to the crt cathode and lowering the plate voltage. This lowers the crt cathode voltage and unblanks the tube.

Section V. ANTENNA POSITION INDICATING SYSTEM

57. Deflection Coil Servo Loop

(fig. 58)

Antenna position data from the master radar is applied to the stator windings of synchro control transformer B602. The error voltage developed in the rotor is applied to the input of the servo amplifier, which in turn delivers the control voltage for two-phase servo motor B603. The amplitude and polarity of the servo amplifier output is such that the servo motor will turn synchro control transformer B602 to eliminate or reduce the error voltage. Deflection coil L609, to which is applied the sweep voltages, is driven by servo motor B603 so that the crt sweep follows the movements of the master radar antenna.

58. Theory of Synchro Operation

a. General. Four essential elements of the deflection coil servo loop (par. 57) are: The synchro generator, located in the master radar set; the synchro control transformer (B602 in the remote ppi); the servo amplifier; and the servo motor that drives the control transformer and the deflection coil. The basic function of the synchro generator in the master radar is to transmit the precise rotating movements of the antenna to the remote ppi by electrical conductors. The basic function of the synchro control transformer is to develop electrical control signals the magnitude and polarity of which are determined by both the applied voltage and the relative mechanical positions of the rotor and

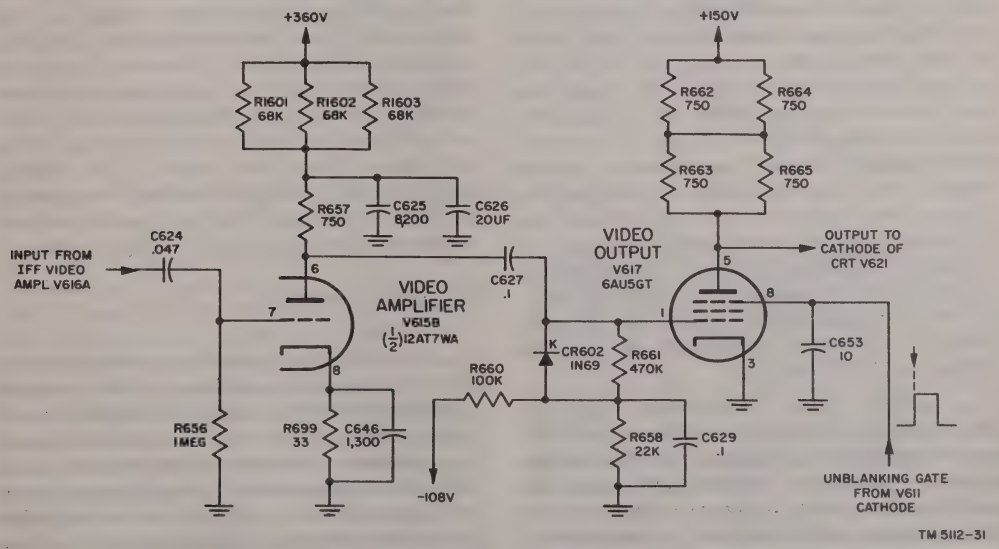


Figure 31. Video amplifier and video output amplifier, simplified schematic diagram.

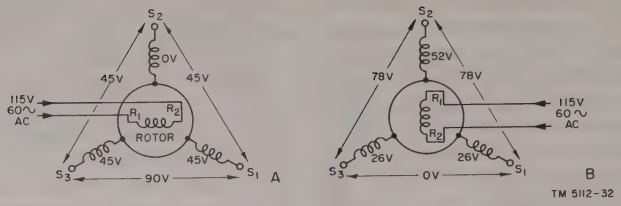


Figure 32. Theory of synchro generator operation.

stator windings.

b. Synchro Generator. The synchro generator develops an output ac voltage, the magnitude and phase of which are determined by the mechanical position of its rotor. In figure 32, when 115 volts ac is applied to the rotor coil, an ac voltage is induced in the stator coils the amplitude of which is determined by the degree of magnetic coupling between the rotor and stator windings. The degree of coupling between the rotor and each of the stator coils is changed by revolving the rotor. Therefore, when the rotor is in the position indicated in A, figure 32, equal coupling exists between the rotor and the stator coils connected to S1 and S3, and equal voltages are induced in them. The stator coil connected to S2 is perpendicular to the rotor coil; therefore, no coupling exists and zero voltage is induced. If the coil characteristics are such that the induced voltage in each coil is 45 volts, then the open-circuit voltages at S1, S2, and S3 will be those indicated in A, figure 32. When the rotor is in the position shown in B, figure 32, maximum voltage is induced in the S2 coil with smaller amounts in the S1 and S3 coils. Induced voltages will therefore add to produce the terminal voltages on S1, S2, and S3 shown on the diagram. These two examples show that the voltages at terminals S1, S2, and S3 will be determined by the angular position of the rotor coil. Each angular position of the rotor is represented by a certain combination of terminal voltages at S1, S2, and S3.

c. Synchro Control Transformer. The synchro control transformer develops a rotor voltage the magnitude and phase of which are determined by the stator voltages applied and the position of the rotor. A, figure 33 shows a synchro generator with the rotor in the electrical zero position and connected to the stator terminals of a synchro control transformer, which is also in the electrical zero position. The stator voltages of the generator will cause currents to flow in the stator coils of the control transformer, which will produce the voltage drops indicated in A, figure 33. No voltage will be induced in the rotor coil because coil S2 is perpendicular to it, and coils S1 and S3 induce equal and opposite voltages which cancel out. In B, figure 33 the rotor of the synchro control transformer has been rotated 120°, and 47.5 volts are induced in the rotor from S2 and S1. When the rotor of the synchro control transformer is turned to 300° (C, fig. 33), the induced voltage on the rotor coil is also 47.5 but the instantaneous polarity will be opposite from that appearing when the rotor is at 120°. D, figure 33 shows the synchro transmitter and the synchro control transformer both at 120°. Under these conditions, the induced voltage on the rotor is zero. Thus, when the stator of a synchro generator is connected to the stator of a synchro control transformer, the magnitude and phase (polarity) of the control transformer rotor voltage is determined by the relative position of the two rotors. When the rotors of the synchro generator and the synchro control transformer are both in the same relative angular position, the control transformer rotor output is zero.

59. Servo Amplifier

(fig. 34)

a. Error voltage induced in the rotor winding of synchro control transformer B602 is applied to the grid of voltage amplifier V623A through network Z604. This is a notch network designed to accentuate sidebands of the 60-cycle error voltage to increase motor torque during periods of acceleration and to provide a braking effect during deceleration. During a period of rate of change of tracking, sideband frequencies are present because of the relative motion between

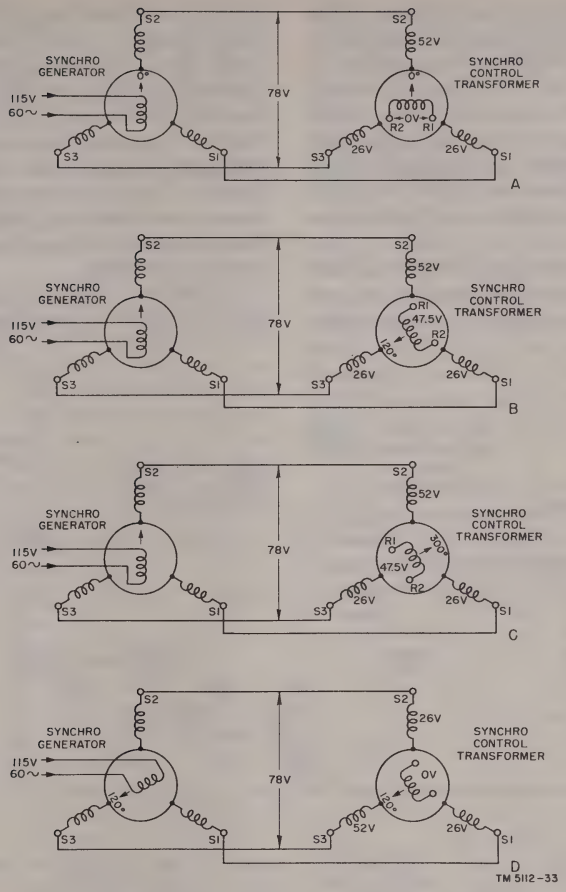


Figure 33. Theory of synchro control transformer operation.

the synchro generator and the synchro control transformer. These sideband frequencies are less attenuated by the network than is the normal 60-cycle signal; consequently they are more effective in accelerating or decelerating the motor to meet the new tracking rate.

b. Voltage amplifiers V623A, V623B, and V624A are conventional resistance-coupled voltage amplifiers. Resistor R1625 is the cathode-biasing resistor for V623A and R1626 is the plate load resistor. Signals from V623A plate circuit are coupled to the grid of V623B through coupling capacitor C657 and appear across grid resistor R1628. Cathode bias for V623B is developed across R1629. The plate load resistance is R1630. Capacitors C655, C656, and C659 and resistor R1627 introduce a phase lag of approximately 110° at 60 cycles to produce the quadrature voltage for the two-phase servo motor and compensate for the phase shift introduced by the synchro control transformer. Capacitor C658 couples the signal over to V624A grid, and R1631 is used to adjust the over-all gain of the servo amplifier. Resistor R1633 is the V624A plate load resistor and R1632 provides the bias.

c. Paraphase amplifier V624B receives the signal from voltage amplifier V624A through coupling capacitor C660 and delivers two out-

puts of opposite polarity for the push-pull power amplifiers. Resistor R1634 introduces some signal attenuation and improves the stability of the servo amplifier. The two opposite polarity outputs are taken off at load resistors R1637 and R1639 and are coupled over to the push-pull power amplifier grids through coupling capacitors C662 and C663. Resistor R1638 is the cathode-biasing resistor for V624B and R1636 is the grid resistor.

d. Push-pull power amplifiers V625 and V626 are conventional. They furnish power to the control winding of two-phase servo motor B603, which constitutes the plate load of these tubes. Approximately —17.5 volts of grid bias for V625 and V626, developed in voltage-divider network of R1642 and R1643, are applied to the control grids through grid resistors R1640 and R1641. To stabilize the amplifier, a degenerative feed-back voltage from V626 plate is coupled back to V624B grid through C661 and R1635. Capacitors C666 and C664 are used for impedance matching between the servo amplifier and servo motor B603.

e. The error voltage from B602 is either in phase or 180° out of phase with respect to the

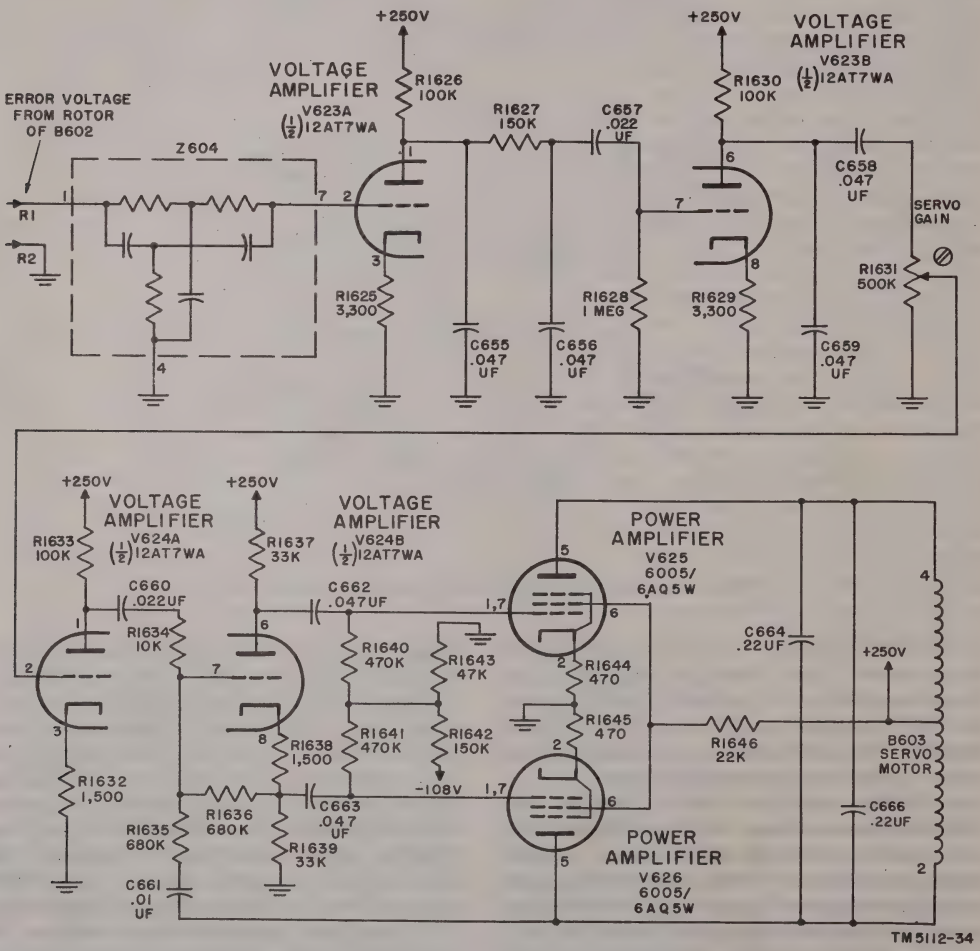


Figure 34. Servo amplifier, schematic diagram.

synchro excitation voltage, depending upon the direction of synchro rotation. A 90° phase lag is introduced in the error voltage by the servo amplifier. Therefore, the output of the servo amplifier that is applied to the servo motor is either leading or lagging the excitation voltage, depending upon the direction of synchro rotation, and thus determines the direction of servo motor (B603) rotation.

Section VI. POWER SUPPLY AND CONTROL CIRCUITS

60. Positive Dc Supply

(fig. 35)

a. Step-up transformer T602 furnishes the plate voltage for the rectifiers that supply the positive dc voltage for operating the electron tubes in this unit. This transformer has one multiple-tapped secondary that furnishes the voltage for the two full-wave rectifying systems that produce these dc voltages. The supply for the negative dc power supply rectifier (par. 61) is also obtained from this transformer. All filament and heater voltages for the electron tubes in the remote ppi are supplied from transformer T601 (fig. 59).

b. The portion of T602 secondary between terminals 4 and 6 furnishes approximately 425 volts, center-tapped, to the plates of full-wave rectifier V601. The center tap is grounded. Full-wave, rectified direct current from V601 filament is filtered by a single L-section filter consisting of choke L601 and capacitor C604. Under normal load conditions, when the remote ppi is in full operation, this rectifier power supply furnishes a nominal +150 volts to the electron tube circuits.

c. Approximately 894 volts developed across the entire secondary of T602 is applied to the plates of full-wave rectifier V602. The center tap (terminal 5) is grounded. Full-wave, rectified direct current from V602 filament is filtered to

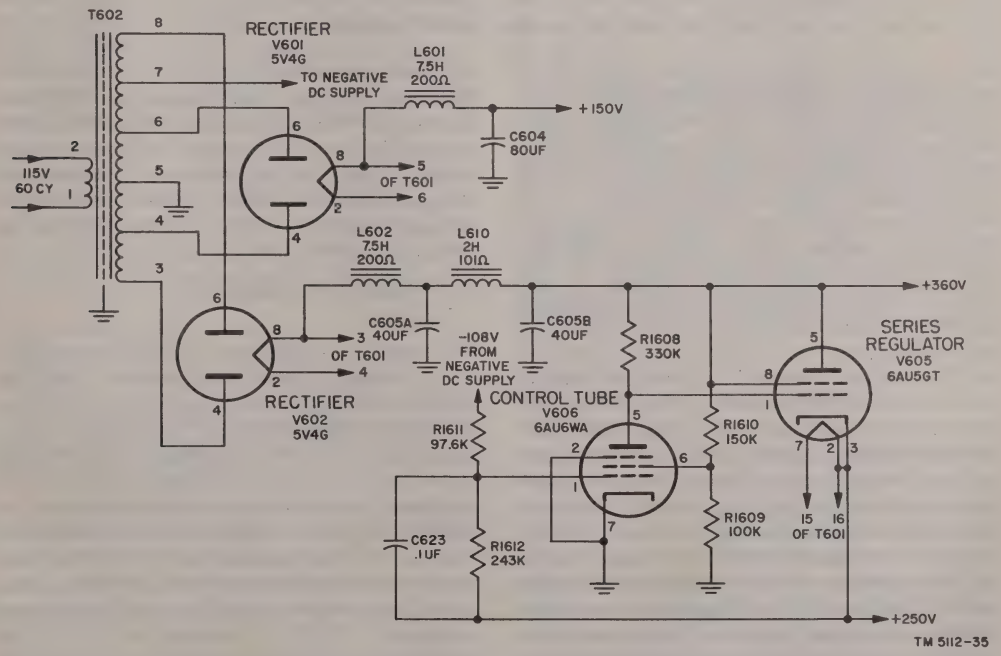


Figure 35. Positive dc supply, simplified schematic diagram.

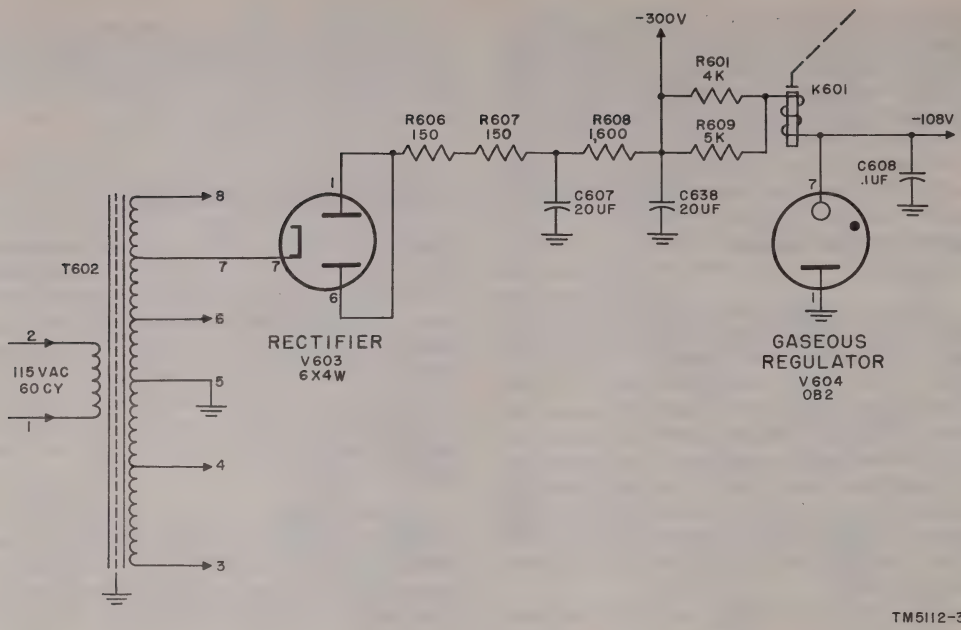


Figure 36. Negative dc supply, simplified schematic diagram.

remove the unwanted ripple and passed on to the electronic voltage-regulator circuit. The filter consists of L602, L610, C605A, and C605B. This power supply furnishes rectified and filtered direct current to the electron tube circuit at +360 volts nominal under full load.

d. Control tube V606 and series regulator V605 are connected in a voltage-regulator circuit to provide +250 volts regulated for the electron tube circuit. Regulation is accomplished by automatically controlling the grid bias on a series regulator tube. When the output voltage (at V605 cathode) tends to decrease, the voltage on the grid of V606 goes more negative as determined by the voltage distribution across voltage divider R1611 and R1612. This causes the current through control tube V606 to decrease and its plate voltage to rise. Therefore, the voltage on the control grid of V605 changes in the positive direction, therefore lowering the effective resistance of series regulator tube V605 and causing the output voltage to rise and counteract the tendency to lower. The action of the voltage-regulator circuit on a rising output voltage is the same as that described above though in the opposite direction. Resistor R1608 is the plate load resistor for control tube V606 and resistors R1609 and R1610 constitute the voltage divider that determines V606 screen grid voltage. Capacitor C623 bypasses V606 grid and thus prevents any rapid voltage fluctuations, such as transients or ripple, from operating the voltage regulator circuits.

61. Negative Dc Supply

(fig. 36)

a. Step-up transformer T602 also furnishes the ac voltage for half-wave rectifier V603 that supplies the negative direct-current voltages for the electron tube circuits. Tube V603 is connected as a half-wave rectifier with the two plates in parallel. The rectified output of V603 is filtered by RC low-pass filter consisting of R606, R607, C607, R608, and C638. This filter reduces the ripple component of the voltage output to a satisfactory level and provides a nominal —300 volts for use in the electron tube circuits.

b. Resistors R601 and R609, relay coil K601, and gaseous voltage regulator V604, are con-

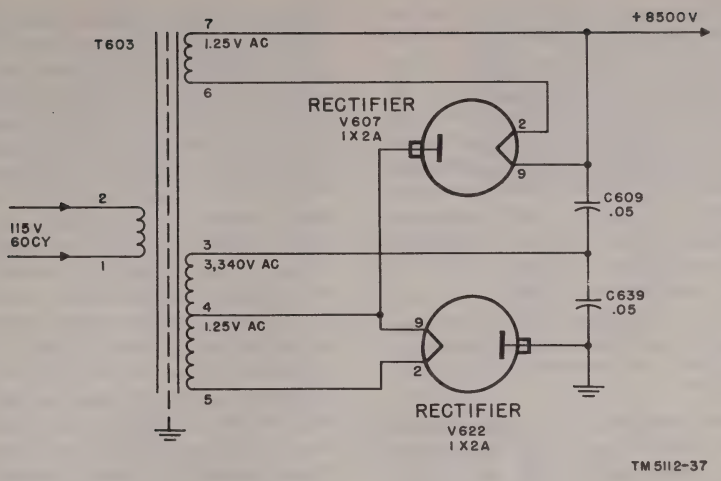


Figure 37. Crt high-voltage power supply, simplified schematic diagram.

nected across the —300-volt output of this power supply. Tube V604 is a voltage-regulating tube that operates so that any change in current flowing through the tube causes a change in its effective plate resistance that tends to oppose the change in current. Therefore, the voltage (—108 volts) across V604 remains relatively constant even though the nominal —300 volts applied across the tube and resistors may vary. The balance of the —300 volts (—192 volts) is dropped across R601, R609, and K601. Capacitor C608 reduces the transients that may appear across gas-filled regulator tube V604. Refer to paragraph 63 for the operation of relay K601.

62. Crt High-voltage Supply

(fig. 37)

a. High voltage for the cathode-ray tube anodes is obtained from a voltage-doubler power supply, which includes step-up transformer T603 and rectifier tubes V607 and V622.

b. During the half-cycle when terminal 3 of T603 is positive with respect to terminal 4, half-wave rectifier tube V622 conducts and charges capacitor C639 up to the peak secondary voltage less the drop across V622. During the following half-cycle when terminal 3 of T603 is negative with respect to terminal 4, rectifier V607 conducts and charges capacitor C609 up to the peak voltage of T603 (less the drop across V607). The polarity of the charge across each of these capacitors (C609 and C639) is additive so that the output voltage of the voltage-doubler rectifier is the sum of the charge across the two capacitors.

c. A nominal +8,500 volts dc is applied to the final accelerating anode of the cathode-ray tube. Voltage-divider network consisting of R692, R693, and R695, connected across the high-voltage power supply, furnishes a bleeder resistance across voltage-doubling capacitors C609 and C639 through which these capacitors discharge (fig. 59). This network also furnishes approximately +400 volts for grids 2 and 3 of the crt. Electrostatic-focus adjustment R693 is a part of this divider network.

63. Control and Ventilating Circuit

(fig. 38 and 39)

a. Protective Relay Circuit. Protective relay K601, the actuating coil of which is located in the negative dc power supply (par. 61), delays the application of high voltage and unblanking voltage to the cathode-ray tube until the electron tube heaters have had time to warm up. This is necessary to prevent possible damage to the cathode-ray tube, because high-voltage rectifiers V607 and V622 have directly heated cathode and have a short warm-up period. The action of K601 is as follows:

(1) Closing the POWER-OFF switch (S601) energizes plate and filament transformer T601 and T602 (*c* below), therefore applying power to all indirectly heated cathodes. After a delay of approximately 1 minute during which its indirectly heated cathode is warming up, rectifier V603 starts conduction. As soon as V603 starts conducting, the current drawn by gaseous regulator V604 through R601 and R609 actuates relay K601.

Note. For identification in the following discussion, the three switching sections of relay K601 are designated 1, 2, and 3, in figure 38.

(2) Closing contacts S1 of relay K601 connects the primary of high-voltage power transformer T603 to the 115-volt ac line.

(3) Closing contacts S2 of relay K601 connects the screen grid of V617 to the cathode circuit of V611 (par. 50), thus permitting the unblanking gate to be applied to the screen of V617. Closing this relay also connects the sweep gate to the screen grids of sweep generators V613 and V614. When K601 is open (de-energized) the screen grids of V613, V614, and V617 are connected to ground.

(4) Closing contacts S3 of relay K601 connects grid 1 of the cathode-ray tube to the voltage-divider network that furnishes the required voltage for the desired intensity. This network includes R688, INT control R687, R686, and the resistance selected by RANGE switch S604 (*b* below). When K601 is de-energized, grid 1 of the crt is connected to —300 volts through resistor R690. This connection applies a cutoff bias to the crt so that the residual charge remaining on capacitors C609 and C639 (fig. 37) will not damage the crt when the POWER-OFF switch is turned to OFF. Capacitors C637 and C654 (fig. 38) prevent undesirable transients from adversely affecting the operation of the crt.

b. Intensity Compensation Circuit. Resistors R682, R683, and R684, connected to a section of RANGE switch S604, are used to compensate for the effect of the different sweep speeds on intensity. On the 20-mile range when the sweep must traverse the crt radius in a shorter time, the faster sweep would tend to make a sweep trace of lighter intensity than would the slower sweep of the longer ranges. Therefore, when S604 is in the 20 position, the +150 volts is connected directly to R686 to establish a certain voltage at the arm of INT control R687. In the 40 position of S604, resistor R684 is connected in the intensity voltage-divider network so that the voltage at the arm of R687 is less positive. This reduces the intensity, thus compensating for the slower sweep speed. At the 80- and 160-mile ranges, relatively larger values of resistance (R683 and R682) are connected in the divider network to lower further the potential at crt grid 1, and thereby prevent a change in sweep intensity with the different sweep speeds.

c. Primary Power Distribution (fig. 39). Power to operate the remote ppi at 115 volts, 60 cycle is applied through power input jack J606. Feedthrough capacitors C601 and C602 help to prevent the entrance of transients or noise voltages from the power line. Fuses F601 and F602 furnish overcurrent protection for the primary power distribution circuits in the unit. When in the OFF position, POWER-OFF switch S601 connects space heater HR601 (installed in some equipments) across the line. When POWER-OFF switch S601 is in the power position, the following circuits are energized.

(1) Fuse F608 furnishes overcurrent protection for the synchro excitation circuit. This circuit energizes one winding of servo motor B603 and provides excitation voltage for the synchro generator at the master radar.

(2) Ventilating blower B601 is energized through contacts 1 and 3 of P601 and J601. Fuse F603 furnishes overcurrent protection for this motor and the wiring that connects it.

(3) Filament transformer T601 is energized through fuse F604.

(4) Plate supply transformer T602 and high-voltage transformer T603 are

energized through interlock switch S603. This interlock, for personnel protection, prevents the application of power to these plate and high-voltage supplies whenever the chassis and case assembly is swung or lifted from the mounting base. Fuse F605 provides overcurrent protection for both T602 and T603, and fuse F606 protects only the high-voltage power supply transformer T603. The 6-volt winding between terminals 13 and 14 of transformer T601 is connected in series with the primary of T602. This winding introduces a 6-volt bucking or opposing voltage in the primary circuit

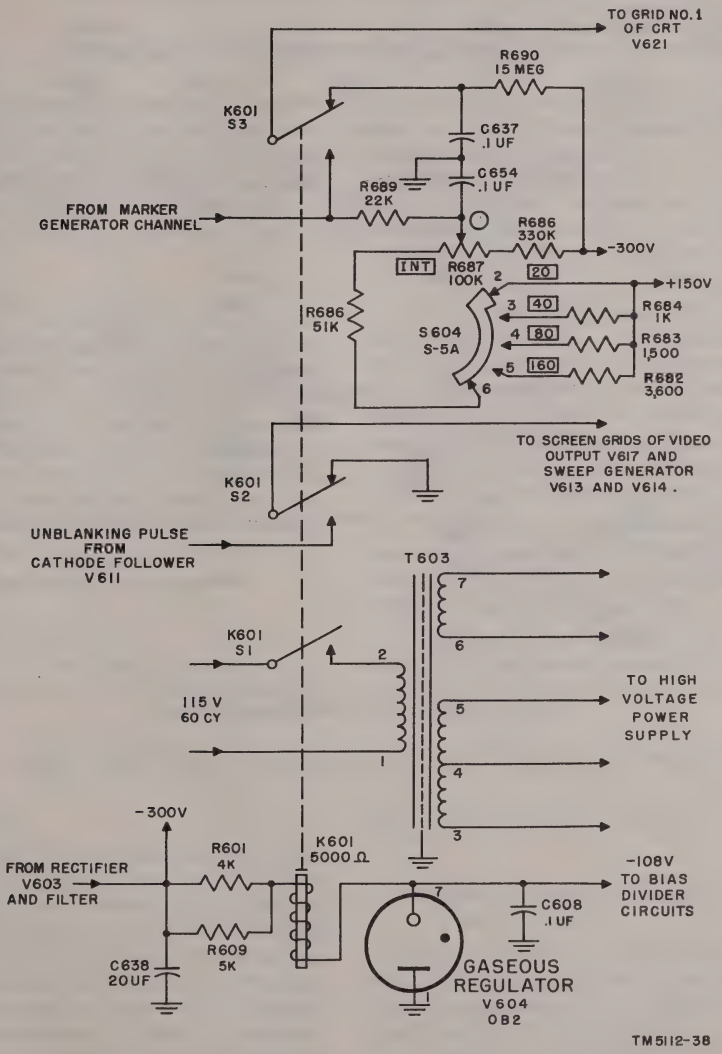


Figure 38. Protective relay circuit, simplified schematic diagram.

of T602. This bucking voltage is used to lower the output voltage of T602 to the required level for this unit. Transformer T602 was designed for use in other equipments, some of which require a higher output capacity. The circuit to the primary of T603 is completed through contacts of protective relay K601 (*a* above).

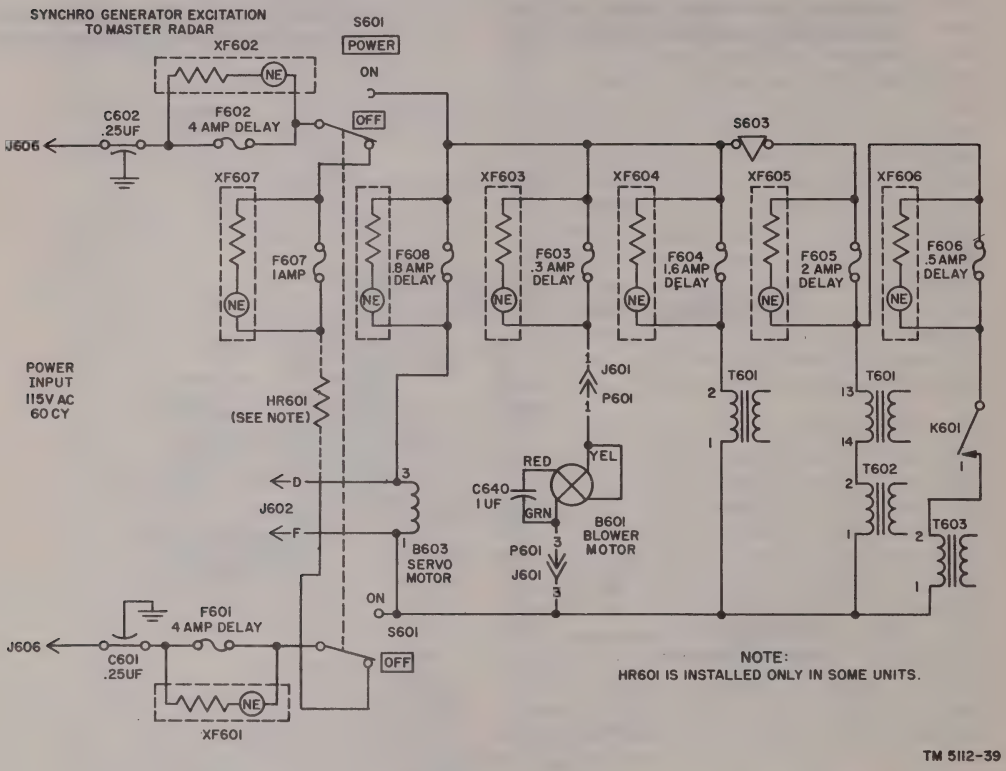


Figure 39. Primary power distribution diagram.

CHAPTER 6
TROUBLE SHOOTING AND REPAIR

Section I. GENERAL INFORMATION

Warning: When servicing the remote ppi be extremely careful because of the high-voltages exposed. Keep away from the cathode-ray tube high-voltage lead at the top of the chassis and the area near the adjacent high-voltage warning plate (fig. 56).

64. General

This chapter describes systematic trouble shooting of Azimuth and Range Indictor IP-345/TPS-1D. These instructions supplement the organizational trouble-shooting instructions given in paragraphs 38 through 46. The systematic trouble-shooting procedure will usually begin with the operational and sectionalization checks at the organizational level (par. 38 through 46) and continue as necessary through the trouble-shooting techniques described in this chapter.

65. Trouble-shooting Steps

a. The first aim when trouble shooting in an apparently defective remote ppi is to determine if the fault lies in the remote ppi, the master radar, or interconnecting cables. Determine if the master radar is operating properly by observing the local indicators and checking for normal operation. This remote ppi requires a positive trigger of at least 5 volts amplitude to operate. Check with an oscilloscope for a trigger at J603 early in the trouble-shooting operation.

b. Sectionalization of the fault to a channel, such as the gate and sweep generating channel, the range marker channel, the video amplifier, the antenna position indicating channel, or the power supply and control system, can often be accomplished by simple operational checks (par. 67). Other times, a more detailed analysis is necessary to sectionalize the fault.

c. Localization of the fault to a particular stage often requires tube checking (par. 41), wave form checking, or voltage and resistance readings (par. 70).

d. Isolation of the trouble to a particular part usually requires visual inspection, voltage measurements, or resistance measurements.

Section II. TROUBLE SHOOTING BASED ON STARTING PROCEDURE

66. Introduction

Performing the starting procedure for the remote ppi while observing indications of proper operation is a useful means of detecting improper operation and localizing the trouble to the circuit or circuits at fault. Personnel performing trouble shooting based on starting procedure should carefully observe the equipment for indications of normal operation. If abnormal indications are observed during starting procedure, reference to starting procedure trouble-shooting chart (par. 67) will aid in locating the fault.

67. Starting Procedure Trouble-shooting Chart

Before performing the starting procedure, place the following controls in the fully counterclockwise position: INT, MARKERS, VIDEO GAIN, and IFF VIDEO GAIN.

a. Turn the POWER-OFF switch to the power position.

Normal indications

(1) Blower motor starts.

(2) Azimuth dial and cursor lights can be turned up by advancing the DIMMER control.

(3) After approximately 1 minute, relay K601 pulls in with an audible click.

Abnormal indications	*Probable location of fault*
(1) Blower, lights, and relay do not operate.	(a) Input Power cable W5. (b) Blown fuse F601, F602, or F603. (c) Faulty POWER-OFF switch S604.
(2) Blower does not operate.	(a) Blown fuse F603. (b) P601 or J601 defective.
(3) Dial lights do not light.	(a) Blown fuse F604. (b) Defective DIMMER control R1624. (c) Faulty lamps I 602 and I 603.
(4) Relay K601 does not close.	(a) Blown fuse F605. (b) Faulty tube V603 or V604. (c) Faulty relay K601. (d) Interlock S603 open or faulty. (e) Defective part in negative power supply (par. 71).

b. Advance INT control in clockwise direction.

Normal indication

Radial sweep trace appears on cathode-ray tube.

Abnormal indication	*Probable location of fault*
No sweep trace appears.	(a) No trigger at J603. (b) Faulty tube (V608 through V614). (c) Other fault in gate and sweep generating channel (par. 71*c*). (d) Fault in power supplies (par. 71*c*).

c. Advance MARKERS control in clockwise direction.

Normal indications

Range marks appear on cathode-ray tube.

Abnormal indications	*Probable location of fault*
No range markers appear.	(a) Faulty tube V608, V609, V618, V619, or V620. (b) Other fault in gate channel and marker channel (71E).

d. Advance VIDEO GAIN control in the clockwise direction.

Normal indications

Video is displayed on cathode-ray tube.

Abnormal indication	*Probable location of fault*
No video is displayed.	(a) No video from master radar at J604. (b) Faulty tube V615, V616, or V617. (c) Other fault in video amplifier channel (par. 71*f*).

e. Rotate master radar antenna.

Normal indication

Sweep rotates in synchronism with radar antenna.

Abnormal indications	*Probable location of fault*
(1) Sweep does not rotate.	(a) Blown fuse F608.
	(b) Faulty tube V623 through V626.
	(c) Other fault in servo amplifier (par. 71*g*).
	(d) B602 or B603 defective.
	(e) Fault in master radar synchro generator.
(2) Sweep rotates in opposite direction to radar antenna.	(a) Error in synchro cable connections (fig. 12).
(3) Sweep sluggish or hunting.	(a) Servo gain adjustment (par. 17*c*).

Section III. TROUBLE SHOOTING IN AZIMUTH AND RANGE INDICATOR IP-345/TPS-1D

68. Reference Data

The following reference data in the manual should be helpful in performing corrective maintenance on the remote ppi.

a. Figure 58, Azimuth and Range Indicator IP-345/TPS-1D, block diagram.

b. Figure 59, Azimuth and Range Indicator IP-345/TPS-1D, schematic diagram.

c. Figure 60, Azimuth and Range Indicator IP-345/TPS-1D, practical wiring diagram.

d. Figure 42, main chassis, tube socket voltage and resistance diagram.

e. Figure 43, servo amplifier, tube socket voltage and resistance diagram.

f. Figure 39, primary power distribution diagram.

g. Figure 40, voltage wave forms, gate and sweep generating channel.

h. Figure 41, voltage wave forms, marker generating channel.

i. Figures 44 through 53, location of detail parts.

j. Figure 61, STD-R1 resistor color code.

k. Figure 62, STD-C1 capacitor color code.

TRIGGER INPUT
J603

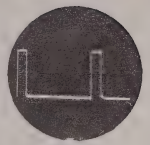
V.M. 10
SW.R .5-5
V 9

LIMITED TRIGGER
V608 PIN 2

V.M. 10
SW.R .5-5
V 4.5

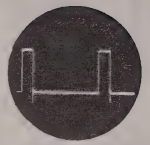
NEGATIVE GATE
V608 PIN 6

V.M. 300
SW.R 500-5K
V 247.5



CATHODE FOLLOWER
INPUT
V609 PIN 5

V.M. 300
SW.R 500-5K
V 210



POSITIVE GATE
V611 PIN 2

V.M. 300
SW.R 500-5K
V 213

SWEEP GATE
(20 MILE)
V613, V614
PIN 8

V.M. 300
SW.R 500-5K
V 162

GATE
REGULATOR
V619 PIN 7

V.M. 300
SW.R 500-5K
V 60

STEP CONTROL
V612 PIN 1

V.M. 300
SW.R 500-5K
V 57

SWEEP GENERATOR
GRID (20 MILE)
V613, V614 PIN 1

V.M. 300
SW.R 500-5K
V 45

SWEEP GENERATOR
PLATE (20 MILE)
V613, V614 PIN 5

V.M. 300
SW.R 500-5K
V 488

SWEEP GENERATOR
PLATE (160 MILE)
V613, V614 PIN 5

V.M. 300
SW.R 500-5K
V 488

NOTES:

1. WAVE FORMS TAKEN ON OSCILLOSCOPE AN/USM-24.
2. V.M. DENOTES V MULTIPLIER.
3. SW.R DENOTES SWEEP RANGE IN MICROSECONDS PER INCH.
4. V DENOTES PEAK-TO-PEAK VOLTS.

Figure 40. Voltage wave forms, gate and sweep generating channel.

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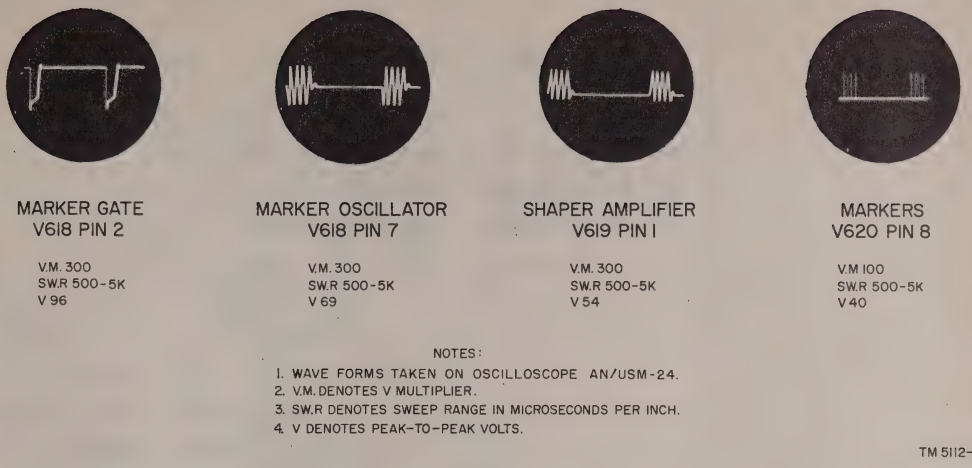


Figure 41. Voltage wave forms, marker generating channel.

69. Trouble-shooting Information

a. Before trouble shooting in the remote ppi, make a visual inspection. Check all fuses (39) and the positions of all switches and controls (par. 21). Check all adjustments (par. 17) and be sure cables are connected properly (fig. 8) and that all plugs and jacks are making good contact. Be sure the supply voltage and frequency is correct and that the proper trigger, video, and synchro data are received from the master radar (par. 4).

b. Often, localization of trouble to a stage is possible by analysis of the cathode-ray tube display. Refer to paragraph 67 for the starting procedure trouble-shooting-chart and paragraph 71 for the trouble-shooting chart. The following general rules apply:

(1) Complete absence of light on the crt directs attention to the power supplies, trigger, or gating circuits.

(2) A bright spot in the center of the crt but no sweep trace indicates a defect in the sweep generating circuits.

(3) The presence of a sweep trace and the absence of markers directs attention to the marker generator channel.

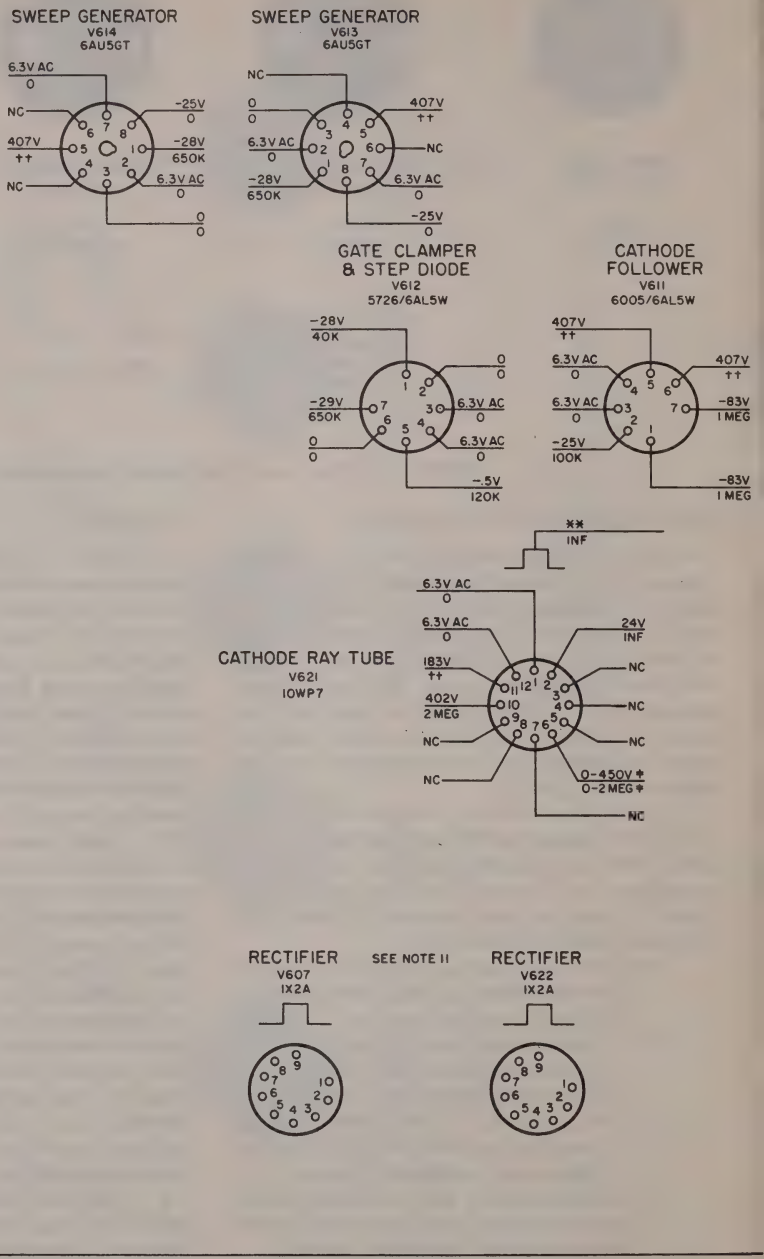
(4) Normal sweep and markers but no echoes indicate possible fault in master radar or video amplifier channel.

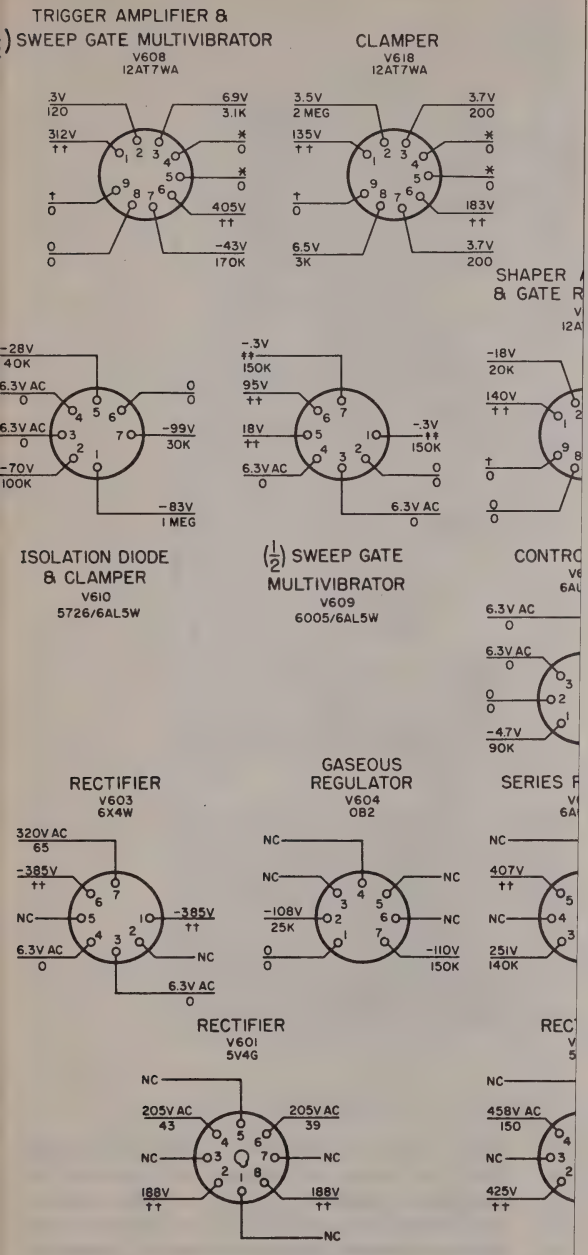
(5) Inoperative or erratic sweep rotation directs attention to the servo-amplifier.

70. Testing

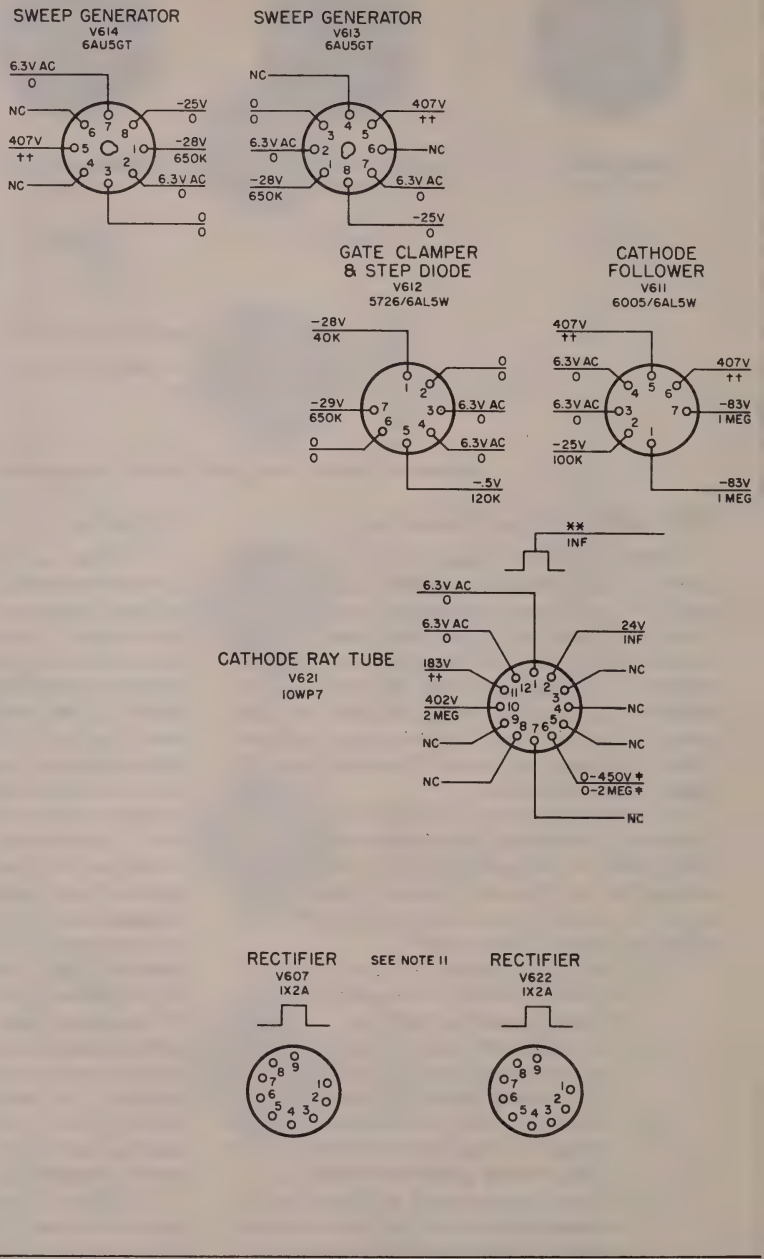
a. Voltage and Resistance Charts. The voltage and resistance charts show the normal voltage and resistance values at the pins of each tube socket. These values were measured on a 20,000-ohms-per-volt meter. The resistance readings were taken with all cables disconnected. These readings are useful in making bench tests on a faulty unit for isolating a defective resistor or capacitor. The voltage readings were taken with all the remote ppi circuits energized except that no trigger is applied to J603. Under these conditions, no gate, sweep, or markers are generated although all tubes and circuits have operating voltages applied. The voltages measured under conditions of no trigger are generally higher than they would be when a trigger was applied. This is caused by the additional power supply loading introduced by the sweep, gate, and marker generating circuits and accounts for the discrepancy between the voltages shown on the charts and those indicated on the schematic diagram as nominal power supply output voltages. These voltage readings are useful in locating faulty tubes or circuit components.

b. Voltage Wave Form Illustrations. The wave form charts show the normal voltage wave form at significant points in the gate and sweep generating channel and in the marker generating channel. These voltage wave forms were


SWEEP GENERATOR
V614
6AU5GT
6.3V AC
0
NC
407V
††
NC
-25V
0
-28V
650K
6.3V AC
0
0
0
SWEEP GENERATOR
V613
6AU5GT
NC
0
0
6.3V AC
0
-28V
650K
407V
††
NC
6.3V AC
0
-25V
0
GATE CLAMPER
& STEP DIODE
V612
5726/6AL5W
-28V
40K
-29V
650K
0
0
0
0
6.3V AC
0
6.3V AC
0
-.5V
120K
CATHODE
FOLLOWER
V611
6005/6AL5W
407V
††
6.3V AC
0
6.3V AC
0
-25V
100K
407V
††
-83V
1 MEG
-83V
1 MEG
**
INF
CATHODE RAY TUBE
V621
10WP7
6.3V AC
0
6.3V AC
0
183V
††
402V
2 MEG
NC
NC
24V
INF
NC
NC
NC
0-450V ±
0-2 MEG ±
NC
RECTIFIER
V607
1X2A
SEE NOTE 11
RECTIFIER
V622
1X2A



igure 42. Main chassis, tube socket voltage and resistance diagra


SWEEP GENERATOR
V614
6AU5GT
6.3V AC
0
NC
407V
++
NC
-25V
0
-28V
650K
6.3V AC
0
0
0
SWEEP GENERATOR
V613
6AU5GT
NC
0
0
6.3V AC
0
-28V
650K
407V
++
NC
6.3V AC
0
-25V
0
GATE CLAMPER
& STEP DIODE
V612
5726/6AL5W
-28V
40K
-29V
650K
0
0
0
0
6.3V AC
0
6.3V AC
0
-.5V
120K
CATHODE
FOLLOWER
V611
6005/6AL5W
407V
++
6.3V AC
0
6.3V AC
0
-25V
100K
407V
++
-83V
1 MEG
-83V
1 MEG
**
INF
CATHODE RAY TUBE
V621
10WP7
6.3V AC
0
6.3V AC
0
183V
++
402V
2 MEG
NC
NC
24V
INF
NC
NC
NC
0-450V *
0-2 MEG *
NC
RECTIFIER
V607
1X2A
SEE NOTE 11
RECTIFIER
V622
1X2A

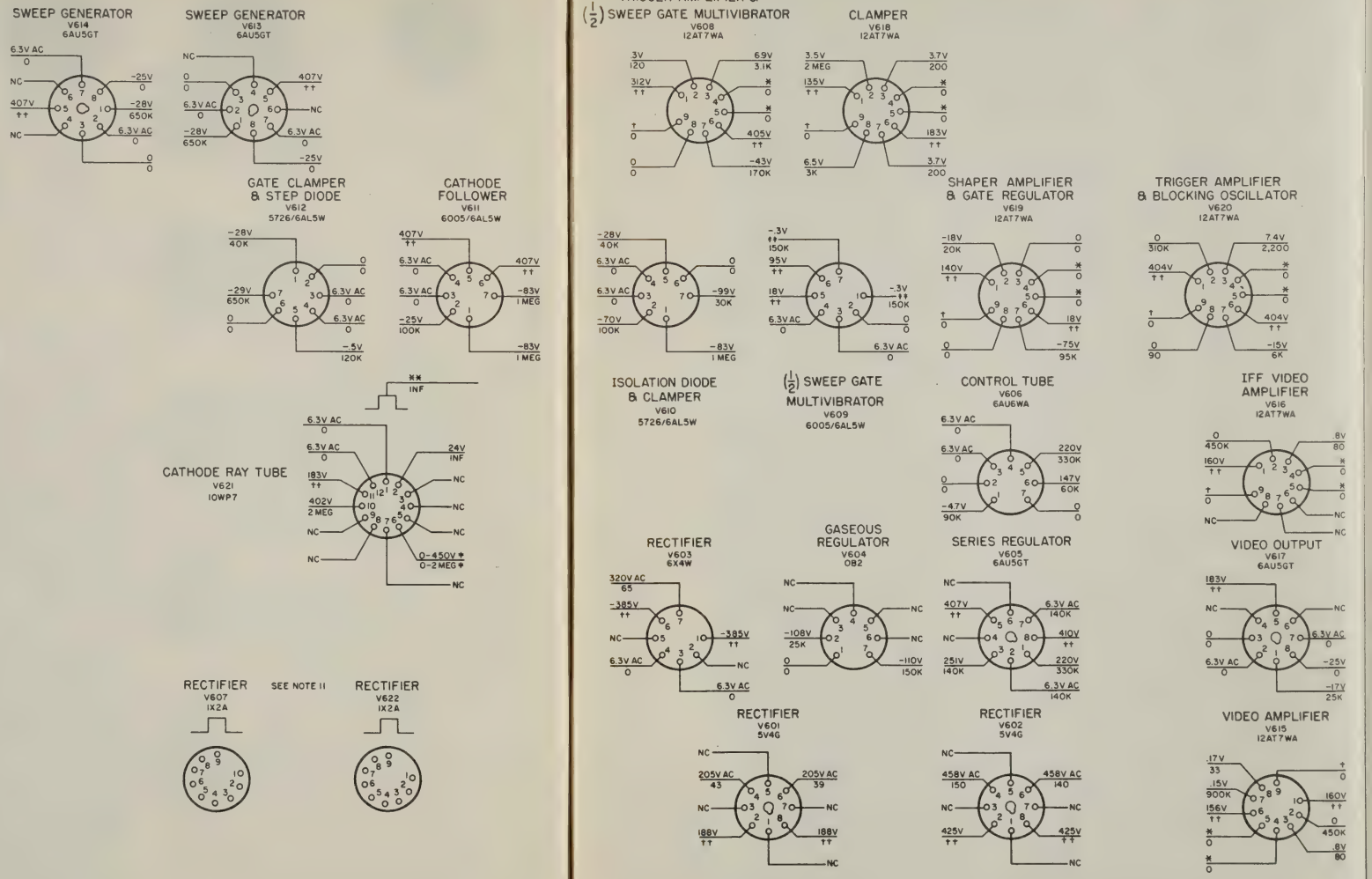


Figure 42. Main chassis, tube socket voltage and resistance diagram.

NOTES

1. ALL READINGS MEASURED TO CHASSIS WITH 20,000 OHMS-PER-VOLT METER.
2. VOLTAGES ARE POSITIVE DC UNLESS OTHERWISE SPECIFIED.
3. RESISTANCE MEASUREMENTS ARE TAKEN WITH EXTERNAL CABLES DISCONNECTED.
4. 6.3V AC BETWEEN PINS SO MARKED.
5. * 6.3V AC TO PIN 9.
6. ** DO NOT MEASURE HIGH VOLTAGE.
7. † 6.3V AC TO PINS 4 AND 5.
8. †† RESISTANCE VARIES BECAUSE OF ELECTROLYTIC CAPACITORS IN THE CIRCUIT.
9. ‡ VOLTAGE AND RESISTANCE VARIES WITH SETTING OF FOCUS CONTROL R693.
10. ** VALUES GIVEN FOR RANGE SWITCH IN 20 POSITION.
11. DO NOT MEASURE VOLTAGES AND RESISTANCES AT RECTIFIERS V607 AND V622. TERMINALS ARE COATED WITH INSULATING MATERIAL.
12. VOLTAGE READINGS ABOVE LINE, RESISTANCE READINGS BELOW LINE.
13. INF DENOTES INFINITY.
14. NC DENOTES NO CONNECTION.

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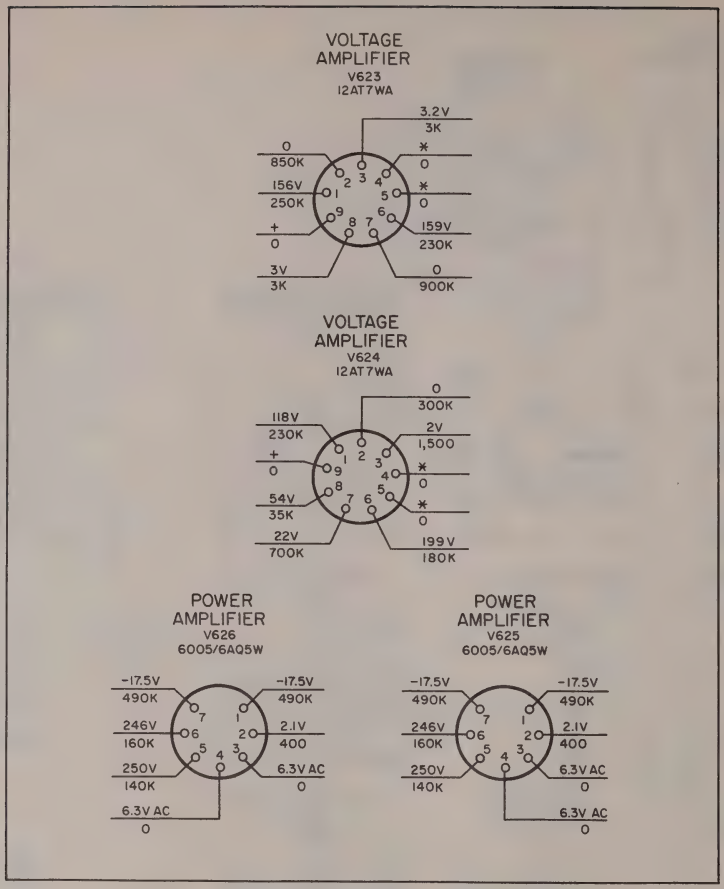

NOTES:

1. ALL READINGS MEASURED TO CHASSIS WITH 20,000 OHMS –PER–VOLT METER.
2. VOLTAGES ARE DC UNLESS OTHERWISE SPECIFIED.
3. RESISTANCE MEASUREMENTS ARE TAKEN WITH EXTERNAL CABLES DISCONNECTED.
4. 6.3V AC BETWEEN PINS SO MARKED
5. * 6.3V AC TO PIN 9.
6. +6.3V AC TO PINS 4 AND 5.
7. VOLTAGE READINGS ABOVE LINE, RESISTANCE READINGS BELOW LINE.

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Figure 43. Servo amplifier, tube socket voltage and resistance diagram.

taken with Oscilloscope AN/USM-24 with the control settings as shown. The trigger input to J603 for operating the remote ppi circuits is supplied from the trigger output jack of the test oscilloscope. If no fault exists in the circuit under test or in the preceding stages, an actual wave form taken at a point in the remote ppi should closely resemble the reference wave form, if the wave forms are taken under the conditions given on the wave form charts. Adjust the horizontal and vertical gain controls for proportional amplitudes, or misleading differences in wave shapes may result. The amplitude, as well as the shape of voltage wave forms, may be significant in detecting a faulty stage. Peak-to-peak voltages are measured on the oscil-

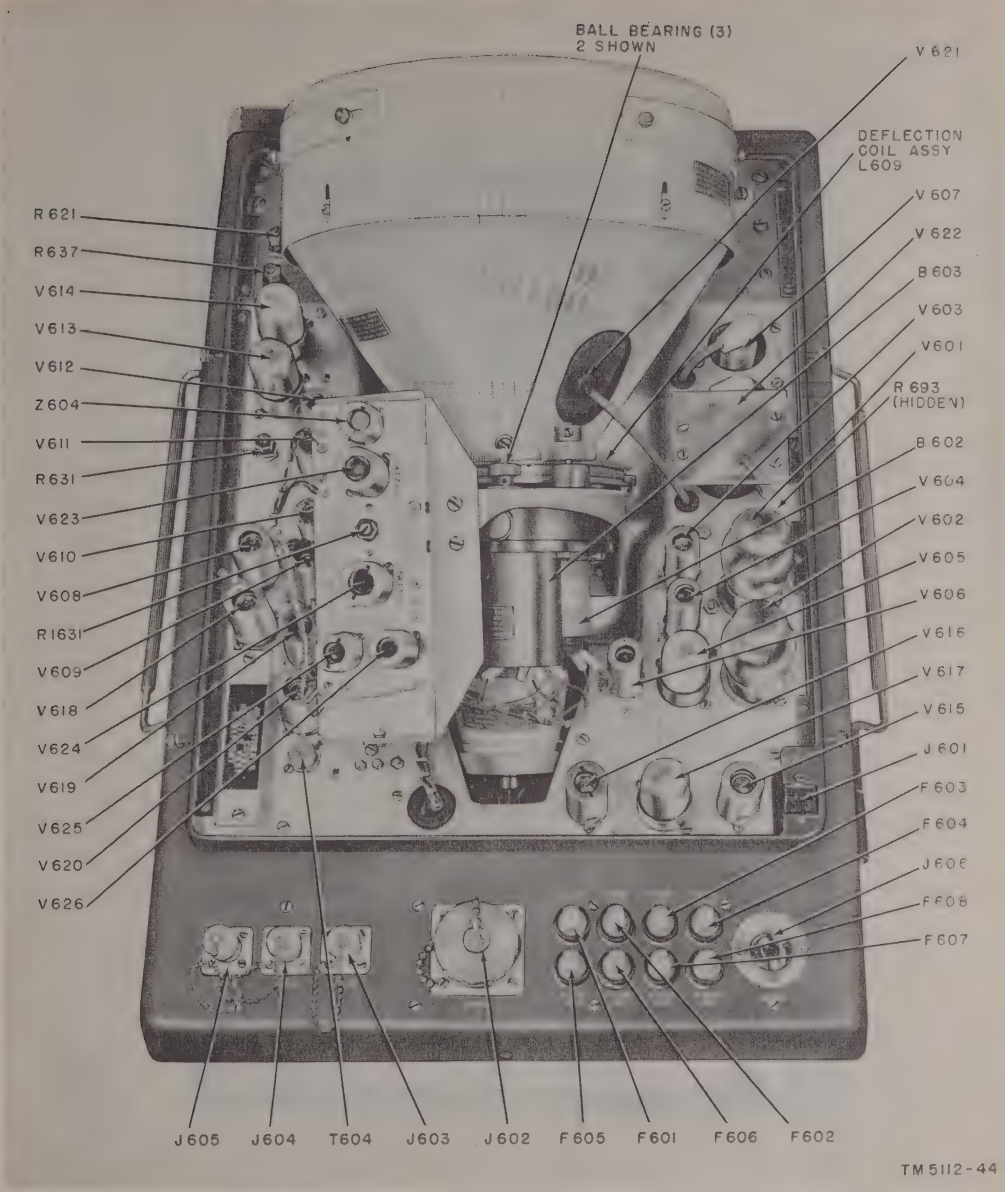

Figure 44. Azimuth and Range Indicator IP-345/TPS-1D, top chassis view, parts location.

loscope by comparing the amplitude of the wave form under test with that of a reference voltage developed in the test oscilloscope. Refer to the manual for the oscilloscope. Comparison of voltage wave forms is useful in sectionalizing trouble to a particular channel or stage.

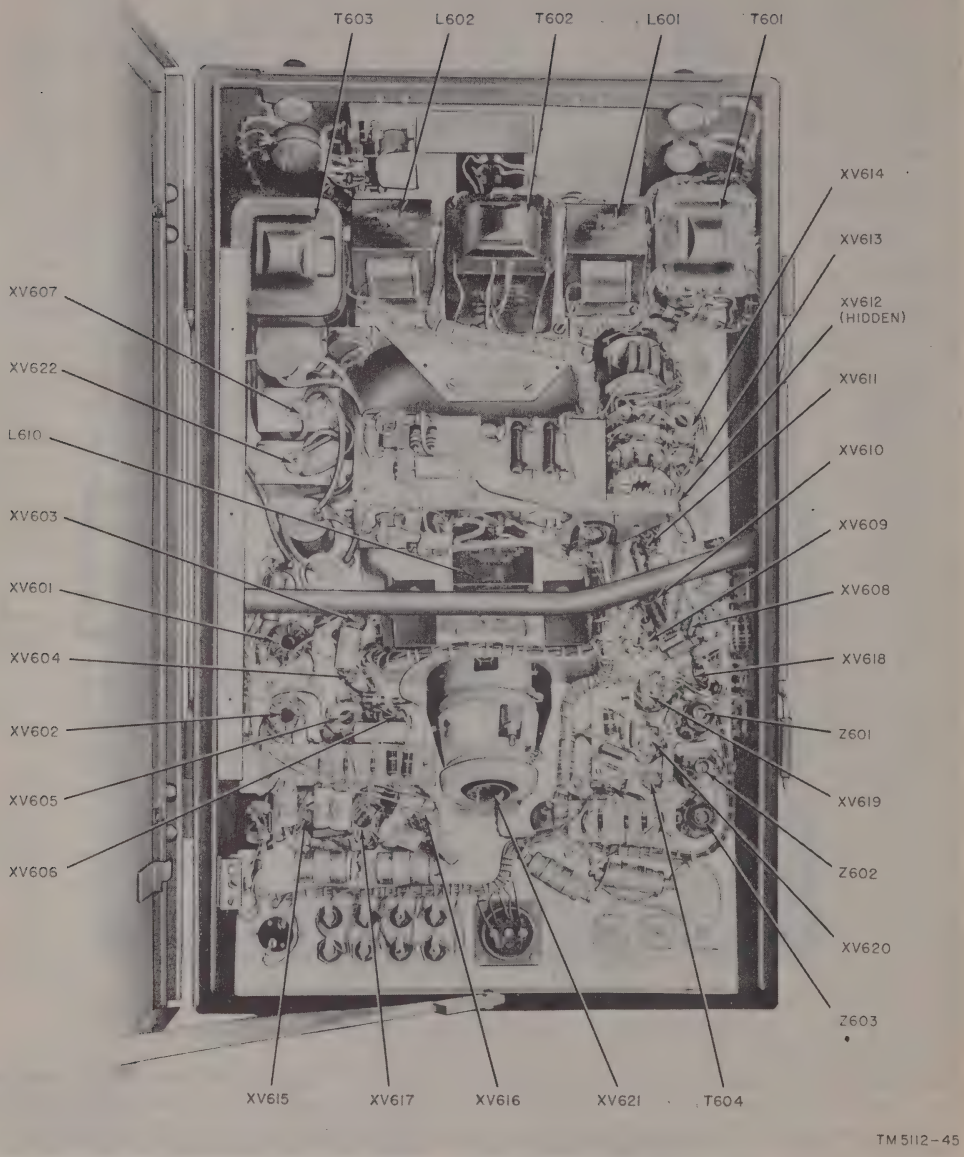

Figure 45. Under chassis view, location of tube sockets, transformers, and inductors.

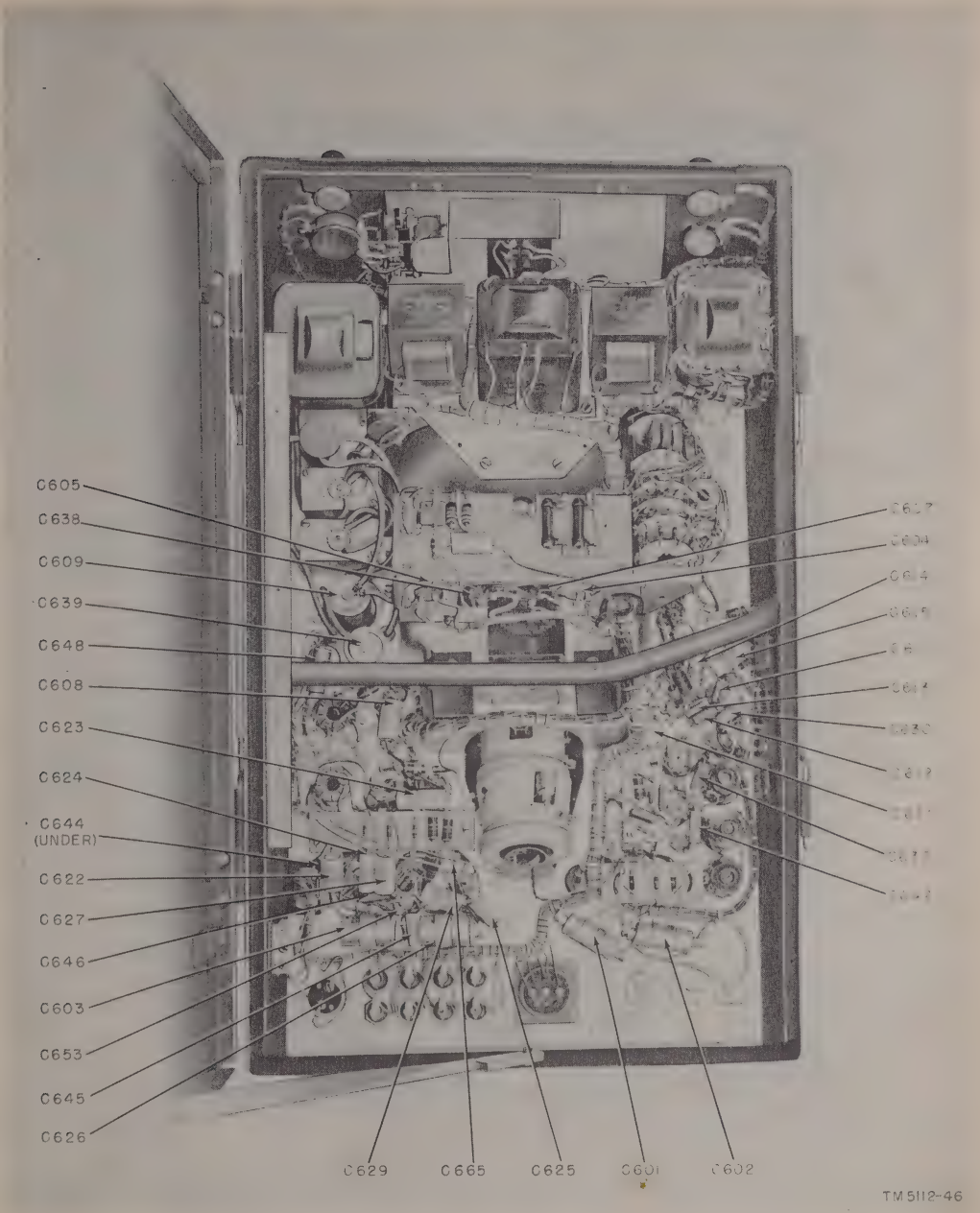

Figure 46. Under chassis view, location of capacitors.

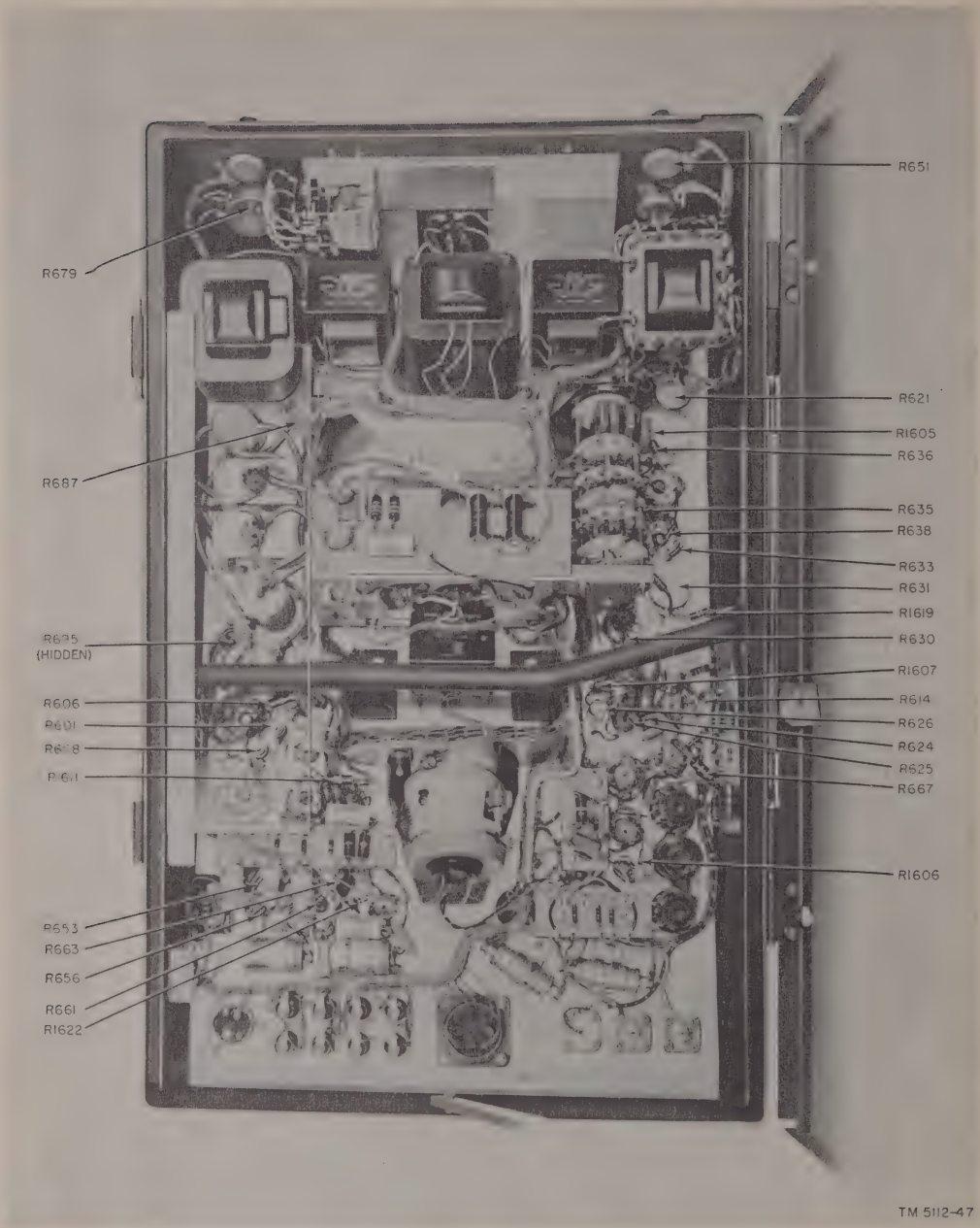

Figure 47. Under chassis view, location of resistors.

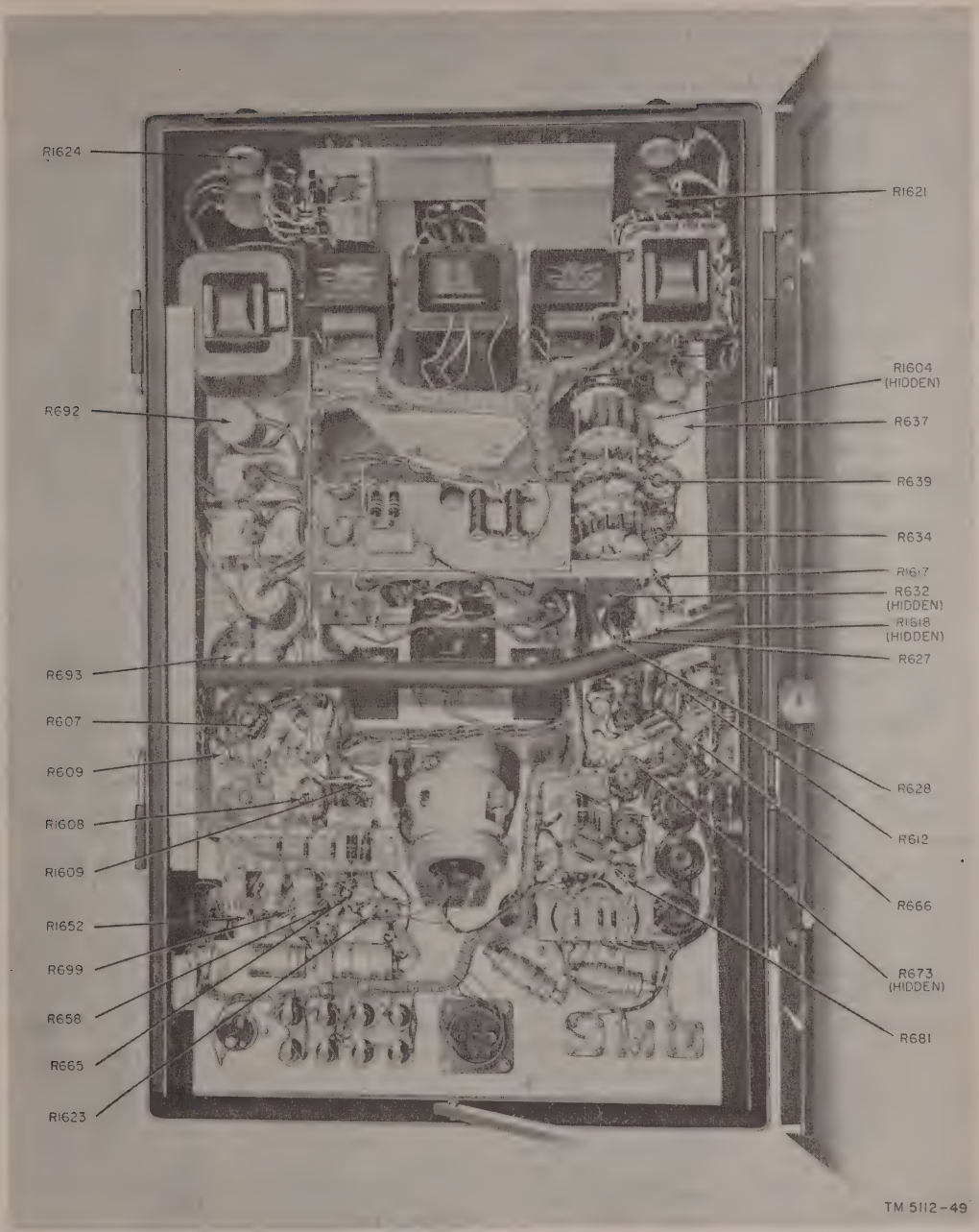

Figure 48. Under chassis view, additional resistors.

c. Tube Checking. A large percentage of failures in equipments of this type is caused by electron tube failure. Both the starting procedure trouble-shooting chart (par. 67) and the trouble-shooting chart (par. 71) indicate that electron tubes are probable causes of trouble. Indiscriminate tube changing should not be practiced. Generally, do not resort to tube changing until the fault has been traced to a particular channel or stage. Recommended organizational maintenance procedures for testing tubes are given in paragraph 41.

71. Trouble-shooting Chart

a. Symptom. Cathode-ray tube remains blank when POWER-OFF switch is turned to the power position and intensity control is turned fully clockwise. Blower does not operate and dial and cursor lamps do not glow when DIMMER control is turned up.

Probable cause	*Procedure*
1. Not connected to power source.	1. Connect to source of 115 volts, 60 cycles.
2. Power input cable or connections at either end faulty.	2. Check power cable W5 and connection at P606 and J606.
3. Blown fuse F601 or F602.	3. Check fuses; replace if necessary.
4. Faulty POWER switch S601.	4. Replace faulty switch.

b. Symptom. Cathode-ray tube remains blank when POWER-OFF switch is turned to the power position and intensity control is fully clockwise. Blower operates but dial and cursor lamps do not glow when DIMMER control is turned up.

Probable cause	*Procedure*
1. Blown fuse F604.	1. Replace blown fuse.
2. Faulty filament transformer T601.	2. Turn POWER-OFF switch to OFF, check primary (terminals 1 and 2) of T601 with ohmmeter; should check at 2.4 ohms. Check leads at T601. Replace T601 if necessary.

c. Symptom. Cathode-ray tube remains blank when POWER-OFF switch is turned to the POWER position and the intensity control is fully clockwise. Blower and the dial and cursor lamps operate normally.

Probable cause	*Procedure*
1. Blown fuse F605 or F606.	1. Replace blown fuse.
2. No trigger from master radar.	2. Check for trigger at J603; use oscilloscope (fig. 46). If no trigger or if trigger is below 5 volts amplitude, check master radar and trigger cable W1. If master radar is Radio Set AN/TPS-1D, check to see that the remote ppi trigger terminating resistor has been removed (par. 14*b*).
3. Defective positive power supplies.	3. Check for approximately +250 volts at pin 3 of V605. If abnormal, check V602, V605, V606, and associated circuit parts. Check for approximately +150 (+35) volts at pin 8 of V601. If abnormal, check V601 and associated circuit parts.
4. Defective negative power supply.	4. Check for approximately —108 volts at pin 2 of V604. If abnormal, check V603, V604 and associated circuit components.
5. Defective high-voltage power supply.	5. Check V607, V622, and T603. Check high-voltage-divider network of R692, R693, and R695. Check for shorted capacitor C648.

Warning: HIGH VOLTAGE. Disconnect power cable W5 and discharge C609 and C639 before making above checks.

Probable cause	Procedure
6. Defective relay K601.	6. Check to see that relay K601 closes as soon as V603 warms up. Replace relay if necessary.
7. Defective tube or component in trigger, gate, or video output circuits.	7. Check V608, V609, V611, and associated circuitry. Check V617 and associated circuitry. Compare wave forms with those shown in figure 40.
8. Defective cathode-ray tube.	8. Replace cathode-ray tube.

d. Symptom. Spot in center of cathode-ray tube, but no sweep is displayed.

Probable cause	Procedure
1. Defective sweep generator.	1. Check V613, V614, and associated circuitry.
2. Open deflection coil L609.	2. Check L609 with ohmmeter (87 ohms). Replace if necessary.
3. Defective slip rings or brushes at L609.	3. Inspect brushes and connections and polish slip rings.

e. Symptom. Normal sweeps on cathode-ray tube and no range marker are displayed when MARKERS control is turned up.

Probable cause	Procedure
1. Defective tube or circuit component in the marker generator channel.	1. Check tubes V618, V619, and V620. Check associated circuit components. Check wave forms against those shown in figure 41.
2. Defective MARKERS control.	2. Check R679 with ohmmeter; replace if faulty.

f. Symptom. Normal sweep and markers are displayed on cathode-ray tube but no echoes appear.

Probable cause	Procedure
1. No video input from master radar.	1. Turn up VIDEO GAIN (R651); if crt screen sparkles (noise present) but no video appears; check for video from master radar at J604. Check master radar and video coaxial cable W2.
2. Fault in video amplifier channel.	2. Check V615 and V617 and associated circuit components. Check for normal voltages and resistances at tube sockets (fig. 42).

g. Symptom. Normal sweep and markers are displayed on cathode-ray tube but sweep does not rotate with the antenna.

Probable cause	Procedure
1. Blown fuse F608.	1. Replace blown fuse.
2. No antenna position data from master radar.	2. Check master radar and synchro cable W4.
3. Defective servo amplifier.	3. Check tubes V623 through V626 and associated circuit components. Check for normal voltage and resistance readings (par. 43).
4. Defective synchro control transformer B602 or servo motor B603.	4. Check windings of B602 and B603.
5. Faulty or damaged deflection coil drive assembly.	5. Check for free rotation of the deflection coil.

h. Symptom. Normal sweep and markers are displayed on cathode-ray tube but sweep oscillates or is sluggish in following antenna movements.

Probable cause	Procedure
1. Servo gain adjustment R1631 is not correctly adjusted.	1. Adjust servo gain R1631 (par. 17*c*).
2. Fault in servo amplifier.	2. Check V623 through V626 and associated circuit componnts.

i. Symptom. Sweep nonlinear particularly near the center of crt.

Probable cause	Procedure
1. Sweep step and adjustments are not correctly adjusted.	1. Adjust sweep step R631 and sweep slope R637 (par. 17*f*).
2. Fault in step control circuitry.	2. Check V610, V612, and associated circuit components. Check step control potentiometer R631 with ohmmeter.

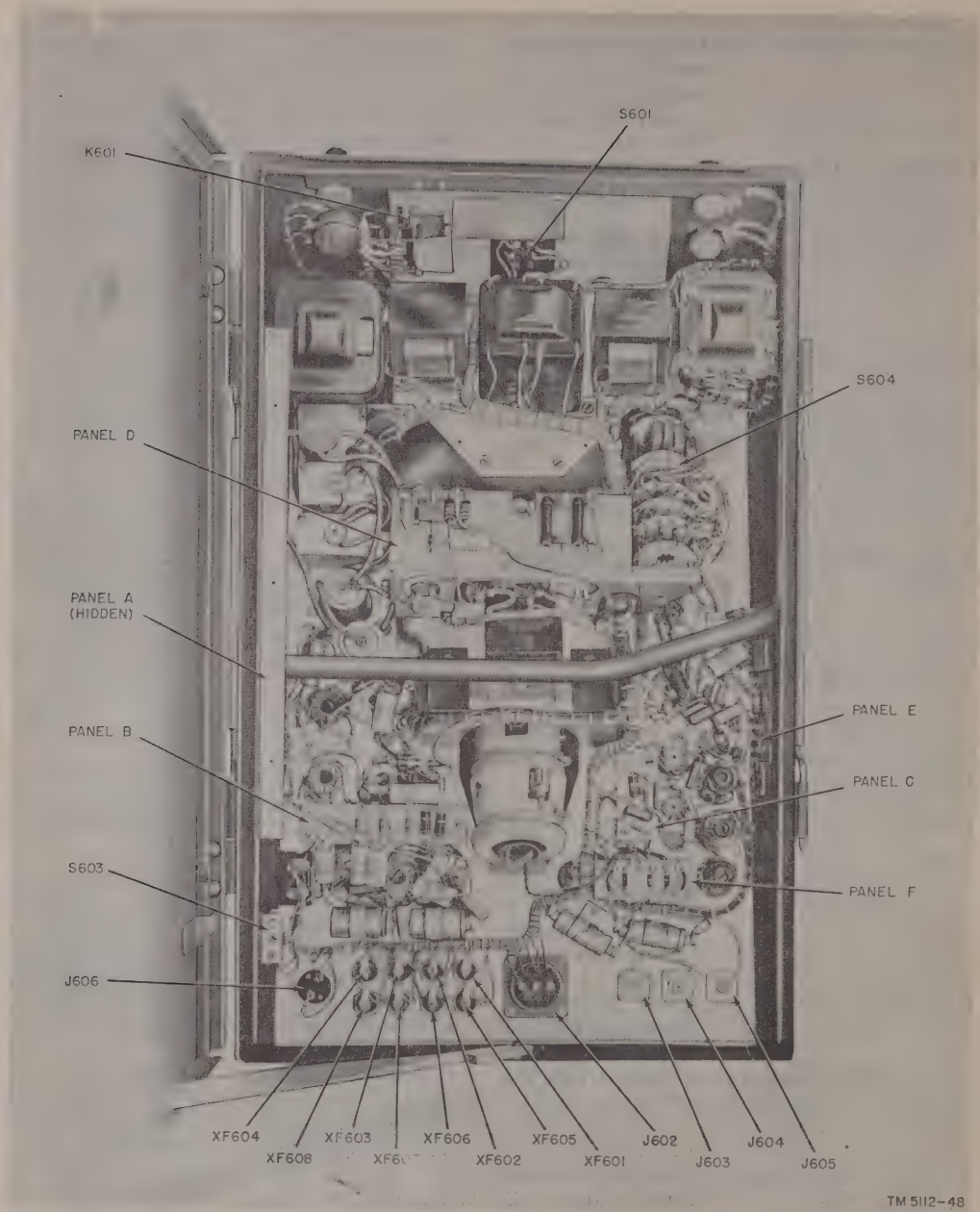

Figure 49. Under chassis view, location of panels and miscellaneous parts.

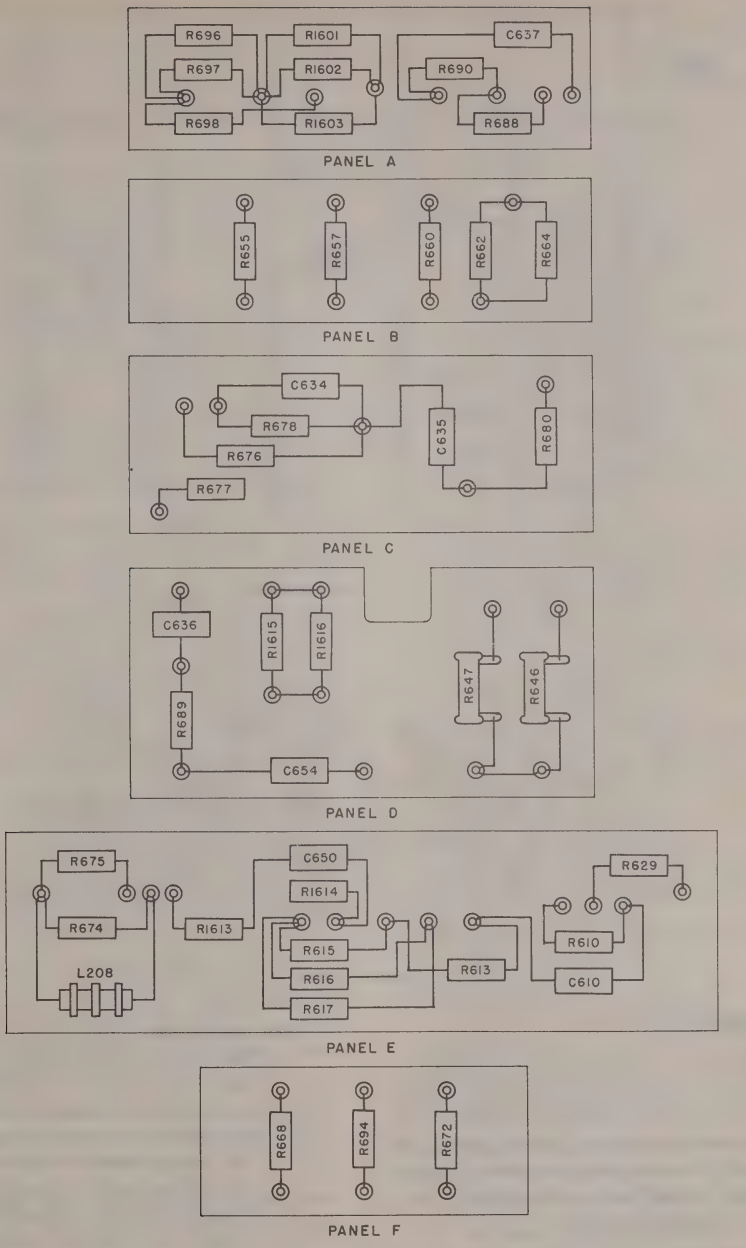

Figure 50. Under chassis resistor and capacitor panels.

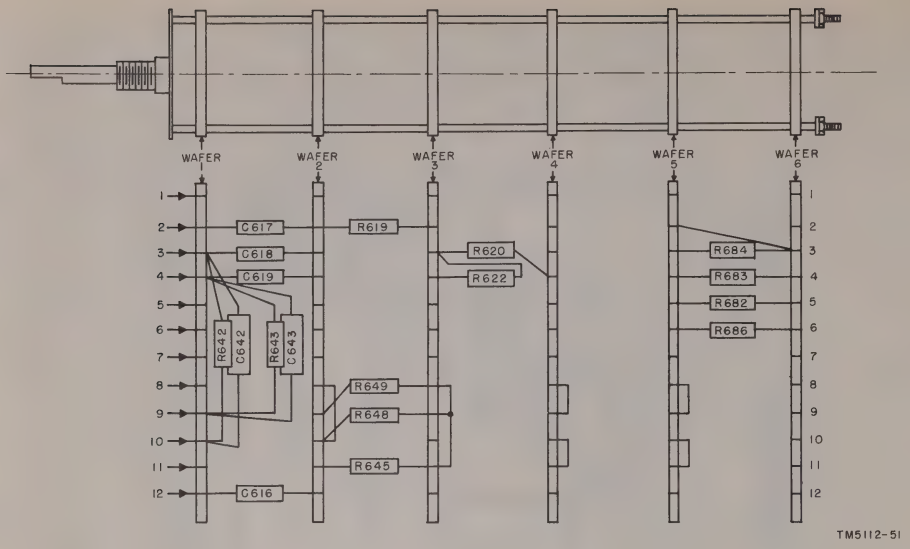

Figure 51. Resistors and capacitors mounted on range switch.

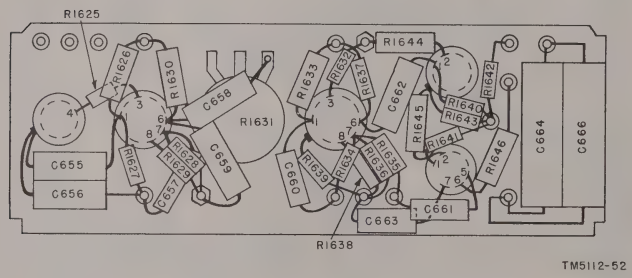

Figure 52. Servo amplifier chassis, location of parts.

72. Removal of Parts

a. Replacement of Azimuth Dial (fig. 53 and 54). The remote ppi is delivered with an azimuth dial calibrated in degrees. A second dial calibrated in mils is supplied and shipped with the spare parts for use when the tactical situation demands. The following procedure is to be used when replacing the dial.

(1) Loosen the four slotted hexagonal head screws (fig. 18), two on either side of the cover, and remove the cover from the chassis and case assembly.

(2) Inside the cover (fig. 53), cut the nylon cord, loosen but do not remove the nut that secures wire bracket MP633, and uncoil the hank of wire leading to the dial and cursor lamps.

(3) At the outside of the cover, remove the three 4-40 x ½-inch binder-head screws from the outer rim of bezel top A 650 (fig. 54), and carefully remove bezel top A 650 from bezel bottom MP604 (fig. 53). Be careful of the small wire that feeds the dial lamp (fig. 54).

(4) Place bezel top A 650 face up on a flat surface and carefully press down on the glass to remove it from the bezel top. It may be necessary to extend the dial lamp wire to place the bezel top face up.

(5) Place the bezel face down and insert the new dial, with the engraved surface down, into bezel top A 650. Be sure the hole in the new dial is aligned with the dial lamp.

(6) Carefully pull the dial lamp wire inside the cover and replace bezel top A650 onto bezel MP604.

(7) Secure bezel top A 650 to bezel bottom MP604 (fig. 53); use the three 4-40 x ½-inch binder-head screws that were removed as directed in (3) above.

(8) Recoil the hank of wire, tie it with nylon cord, and secure the wire with wire bracket MP633.

b. Rotating Bezel Assembly. The remote ppi is designed for mounting in one of three positions (fig. 7). When the unit is mounted in other than the table-top position, the bezel must be rotated 180° so that the bearing scale 0 will be positioned at the top of the bezel. To change the position of the bezel, proceed as follows:

(1) Remove three truss head screws H614 that are nearest the rim of bezel bottom MP604 (fig. 54). Also, remove two binder-head screws H613 from the front of cover A 621. This releases wire brackets MP634 and MP633.

(2) At the inside of the cover, remove the two binder-head knob securing screws 4-40 x ½-inch from the rear of cursor control knob MP603. Remove the knob assembly.

(3) Remove truss head screw H614 that secures wire bracket A 651 (fig. 53) to the inside of the cover.

(4) Cut the nylon cord that secures the hank of wire for the dial and cursor lamps.

(5) From the inside of the cover, rotate bezel bottom MP604 180° in a clockwise direction.

Note. In the following assembly procedures, be sure all lock washers and flat washers are reinstalled.

(6) Secure bezel assembly MP604 in place by using the screws H614 and two binder-head screws H613 that were removed as directed in (1) above.

(7) Install wire bracket MP634 under the nut and lock washer on binder-head screw H613 near the 0° mark at the lower edge of cover A 621. The bracket secures the dial lamp wire in place.

(8) Install wire bracket MP633 under the nut and lock washer on binder-head screw H613 near the 180° mark. This wire bracket is not used to clamp the dial lamp wire in this position, but is attached here for further use for table-top mounting.

(9) Install wire bracket A 651 180° from its former position and secure it by using truss head screw H614 found there. Before tightening the bracket, coil the excess wire, tie it up, and place it under the bracket, then tighten the screw.

(10) Install cursor control knob, by using the two 4-40 x ½-inch binder-head screws that were removed as directed in (2) above.

c. Replacement of Dial and Cursor Lamps. Red cursor lamp I 603 may be replaced from the rear of reflection plotter assembly A 622.

(1) Remove cover A 621 (fig. 54) as outlined in *a*(1) above.

(2) Loosen the 4-40 x ⅜-inch lamp securing screw, and swing the contact clamp to the left.

(3) Use long-nosed pliers and pull the lamp straight out.

(4) Insert the new lamp, swing the contact clamp back over the lamp base, and tighten the lamp securing screw.

(5) Replace white dial lamp I 602 from the front of the unit. Unscrew the dial lamp cover (fig. 17) and pull the lamp straight out. Insert the new lamp and replace the dial lamp cover.

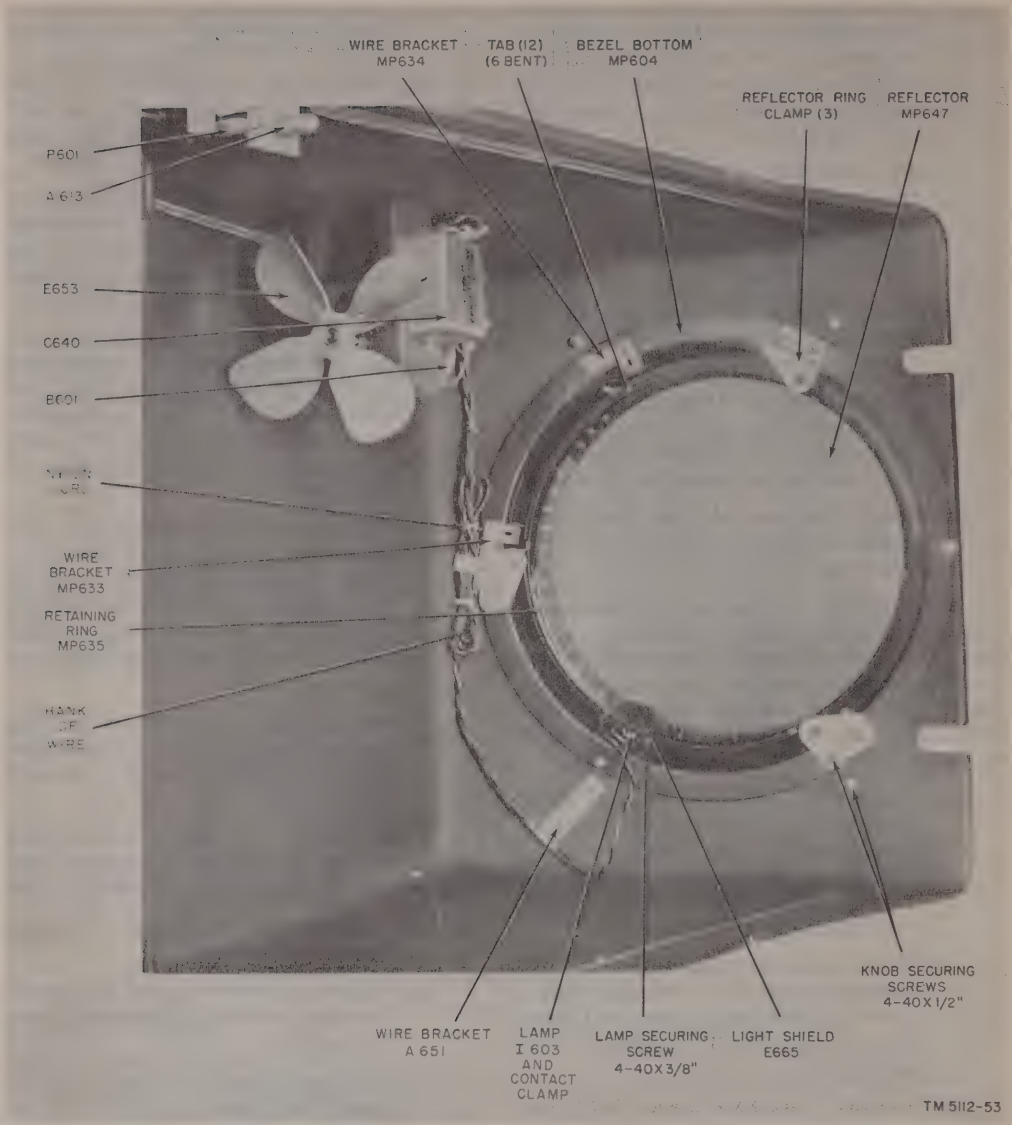

Figure 53. Inside cover assembly.

d. Removal of Cathode-ray tube (fig. 55 and 56).

(1) Remove the cover (*a*(1) above) and disconnect the high-voltage anode lead connected to the crt at the right-hand side (fig. 56).

(2) Open the indicator chassis to the servicing position (fig. 4).

(3) Carefully remove tube socket XV621 from the base of the crt.

(4) Loosen the clamp ring (fig. 55) on the focusing magnet shield. Loosen the two

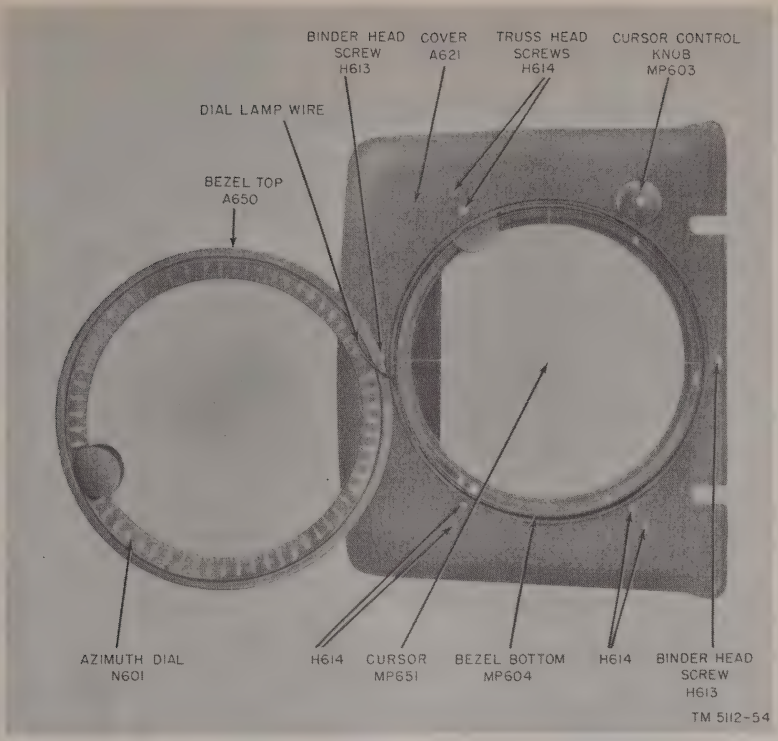

Figure 54. Cover assembly, azimuth dial removed.

machine screws in the slots at the sides of the focusing magnet shield and remove the shield from the magnet assembly.

(5) Loosen the focusing magnet clamping screw and remove the focusing magnet from the neck of the crt.

(6) Loosen the clamp ring on the centering magnet shield. Loosen the two machine screws in the slots at the sides of the centering magnet shield and remove the shield from the magnet assembly.

(7) Loosen the clamping screw and remove the centering magnet assembly from the neck of the crt.

(8) Locate the small horseshoe-shaped cutout in the front of panel D (fig. 55). Insert a screw driver through this cutout and loosen the bottom screw that holds the cathode-ray tube shield by turning it about 2 turns.

(9) Close the indicator to the operate position.

(10) Carefully support the crt and remove the two crt shield securing screws (fig. 56) at the front part of the chassis top on either side of the crt.

(11) Lift the cathode-ray tube, with the shields, out of the chassis.

(12) Remove the four machine screws that hold the two halves of the crt shield together and carefully remove the front half crt shield and the rear half crt shield from the crt. After removing the four screws that hold the two halves of the crt shield together, the two halves may still stick together. If this occurs, work the front and rear halves of the shield apart. *Do not*

hammer or dent the shields as this may destroy or impair their magnetic shielding properties.

e. Installation of Cathode-ray Tube.

(1) Assemble the front and rear halves of the crt shield on to the crt. Replace the four machine screws in the shield. Do not tighten securely. Orient the tube so that the high-voltage anode can be reached through the hole in the rear half crt shield. Orient the two halves on the assembly so that the two mounting feet on the front half crt shield are positioned correctly with respect to the anode connection. Assemble the rear half crt shield forward as far as possible to prevent interference with the deflection coil when mounted in the chassis.

(2) Install the crt and shields into the remote ppi chassis. Secure the mounting feet on the front half crt shield to the chassis with the two crt shield securing screws (fig. 56).

(3) Adjust the position of the rear half crt shield so that it just clears the deflection coil assembly. Tighten the four machine screws that hold the two shield halves together.

(4) Open the remote ppi to the servicing position (fig. 4).

(5) Insert a screw driver through the small horseshoe-shaped cutout in panel D and tighten the screw that holds the rear half crt shield.

(6) Slide the centering magnet onto the neck of the crt. Tighten the clamping screw so that the centering magnet assembly may be rotated on the tube neck but will remain fixed under normal conditions of shock and vibration.

(7) Slide the centering magnet shield over the centering magnet assembly and secure it in place with the two machine screws in the slots at the sides of the shield.

(8) Tighten the clamp ring on the centering magnet shield. Be careful not to tighten the clamp ring too much as this will result in distortion of the centering magnet shield.

(9) Slide the focusing magnet assembly onto the neck of the crt. Tighten the clamping screw so that the focusing magnet assembly may be rotated on the neck of the crt but will remain fixed in place under normal conditions of shock and vibration.

(10) Slide the focusing magnet shield over the focusing magnet assembly and seure it in place with two machine screws in the slots at the sides of the shield.

(11) Tighten the clamp ring on the focusing magnet shield. Be careful not to tighten the clamp ring too much as this may result in distortion of the focusing magnet shield.

(12) Connect tube socket XV621 to the crt base.

(13) Close the remote ppi to the operate position, and connect high-voltage anode lead to the cathode-ray tube.

(14) Rotate the deflection coil assembly by hand a few times to see that the back half crt shield or the centering magnet shield does not interfere with its rotation.

(15) Perform the mechanical focusing and centering alignment given in paragraph 17.

73. Alignment and Adjustment Procedures

a. All alignment and adjustment procedures necessary during normal usage of the remote ppi are given in paragraph 17. These adjustment procedures should be performed in the order given.

b. Range marker oscillator tuning coils Z601, Z602, and Z603 are individually connected into the grid and cathode circuits of range marker oscillator V618B. These connections are made by means of the jumpers on panel F (fig. 16) and the position of RANGE switch S604. These slug-tuned coils have been accurately adjusted at the factory and under normal usage do not need to be adjusted. If detail parts in the oscillator circuits are replaced or the adjustment of these coils becomes disturbed for any other reason, readjustment may be necessary. This adjustment requires the use of precision test equipment in the hands of a skilled technician and therefore should not be made except by

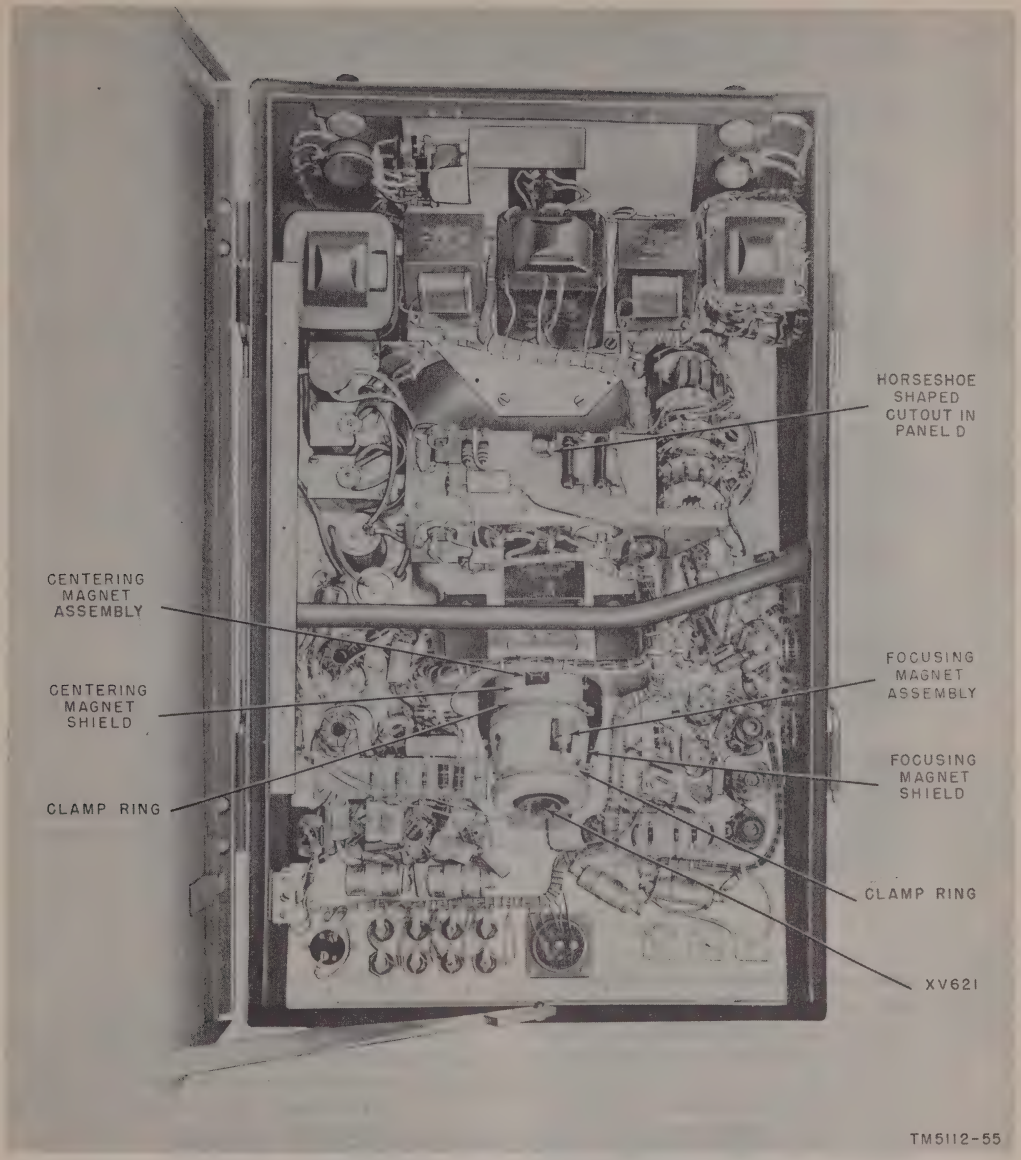

Figure 55. Bottom chassis view, replacement of crt.

qualified personnel.

(1) Use a test oscilloscope that has a delay circuit calibrated in yards (Oscilloscope OS-8A/U, or equivalent) and adjust Z603 so that the markers are 10 nautical miles apart. Refer to the manual for the test oscilloscope and follow the general instructions given below.

(*a*) Trigger the oscilloscope from the

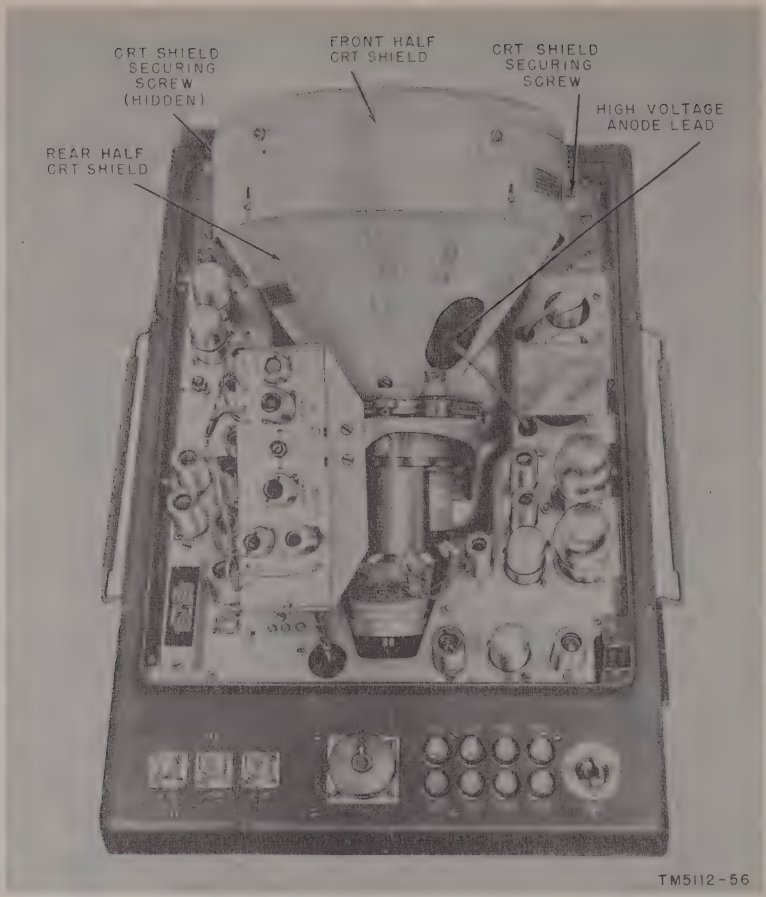

Figure 56. Top chassis view, replacement of crt.

same source that triggers the remote ppi.

(*b*) Connect the range marker jumpers for the 10-mile markers (fig. 16).

(*c*) Connect the test oscilloscope to observe the markers at pin 8 of V620.

(*d*) Adjust the tuning slug of Z603 by using an insulated hexagonal socket wrench so that the markers are 10 nautical miles apart ±1 per cent. The tuning slug adjustments can be reached through the chassis top at the right-hand side near the rear, under a warning plate. Ten nautical miles shall be considered 60,800 feet. (Every third 10-mile marker will be a whole number of yards.)

(2) Adjust Z601 so that the markers are spaced 10,000 yards apart and Z602 so that the markers are spaced 50,000 yards apart. Refer to the oscilloscope instruction book and the general instructions that follow:

(*a*) Connect the range marker jumpers on panel F for the 10,000- and 50,000-yard markers (fig. 16).

(*b*) Trigger the oscilloscope from the same source that triggers the remote ppi and connect the test oscilloscope to observe the markers at pin 8 of

V620.

(*c*) Turn the RANGE switch to the 20 position and adjust the tuning slug of Z601 so that the markers observed at pin 8 of V620 are spaced 10,000 yards apart.

(*d*) Turn the RANGE switch to the 80 position and adjust the tuning slug of Z60 so that the markers observed at R679 are spaced 50,000 yards apart.

Section IV. FINAL TESTING

74. General

After the equipment has been repaired, the remote ppi should meet certain performance standards when connected to a master radar. These performance standards refer to the follow accuracy of the antenna position indicating system, the linearity of the sweep, and the accuracy of the range markers. Proper performance of the alignment and adjustment procedures as given in paragraphs 17 and 73 should provide the performance accuracy required. Azimuth bearing tracking accuracy is 1° with respect to the data of the master radar. Range marks accuracy is ±1 per cent of the indicated range.

75. Tests

a. General. All the alignment procedures given in paragraphs 17 and 73 except servo gain adjustment can be made on a test bench by using a suitable trigger from appropriate test equipment. The characteristics of the trigger used should be within the limits described in paragraph 4.

b. Azimuth Bearing Tracking Accuracy. To test the remote ppi antenna position indicating system for the required 1° bearing tracking accuracy, proceed as follows:

(1) With all the cables connected to the master radar and the equipment energized but the deflection coil not rotating, connect a vacuum-tube voltmeter (Electronic Multimeter TS-505/U, or equivalent) across R1 and R2 of B602.

(2) Adjust servo gain control R1631 to just below the point where oscillations occur. Check at several fixed positions 60 to 80° apart.

(3) Rotate the master radar antenna in each direction, if possible, at 1 revolution per minute (rpm) for at least one full rotation of the deflection coil. The error voltage as read on the vacuum-tube voltmeter should not exceed .5 volt.

(4) Rotate the master radar antenna in each direction at 20 rpm, or its maximum speed if less than 20 rpm. The error voltage as read on the vacuum-tube voltmeter should not exceed .5 volt.

c. Range Markers Accuracy. Refer to paragraph 73 for instructions for adjusting the range marker oscillator coils. By careful use of Oscilloscope OS-8/U, the range markers can be calibrated for a range accuracy of ±1 per cent.

d. Sweep Linearity. Refer to paragraph 17 for instructions that affect the sweep linearity. By careful adjustment of step control R631 and sweep slope R637, ±2 per cent linearity should be obtained except for the first and last 10 per cent of the sweep, which should be ±5 per cent.

Section V. DISASSEMBLY AND REASSEMBLY OF MECHANICAL ASSEMBLIES

76. General

The information contained in this section is given to assist the repairman in disassembly of the deflection coil drive assembly. This disassembly and reassembly should be attempted only by thoroughly qualified personnel, because tolerances are close. To avoid damaging parts, be extremely careful and follow the procedure outlined. Keep the parts clean during the disassembly operations and replace all defective parts with new parts.

77. Disassembly and Reassembly of Deflection Coil Drive

(fig. 57)

a. To disassemble the deflection coil drive assembly, proceed as follows:

(1) Remove the cathode-ray tube (par. 72).

(2) Loosen and remove the two 8-32 x ½-inch machine screws and lock washers (13 and 14) and remove brush block MP605 (15) from base A 602 (12). Contacts E629 and E631 (16 and 17) are attached to MP605.

(3) Loosen the three 8-32 x ½-inch machine screws (11) that secure three ball bearings MP614 (9) and remove three MP614 and bushing MP655 (10). The removal of these three ball bearings permits the removal of the coil and gear assembly E635 (1, 2, 3, 4, and 5) as a single unit. Further disassembly of E635 is seldom necessary.

(4) Loosen the two 4-40 x 7/16-inch machine screws (6) on the hub of spur gear MP649 (7). Remove MP649 from the shaft of gear assembly MP607 (22).

(5) Remove the three 8-32 x ⅝-inch machine screws (8) and remove the entire drive unit (18 through 42) from base A 602 (12).

(6) Loosen and remove the three 8-32 x ⅝-inch machine screws (34) and carefully separate the gear housing plate (32) from the gear housing (21).

(7) Lift gear assembly MP606 (25) and ball bearing MP617 (24) from the gear housing (21). Push ball bearing MP618 (26) out of the bore in the gear housing plate (32).

(8) Push gear assembly MP607 (22) out of the gear housing (21) and extract the retaining ring (18) and ball bearing MP620 (19) out of the bore in the gear housing.

(9) Loosen and remove the 10-32 nut (28) from the shaft of synchro control transformer B602 (39) and remove the washer (29) and spur gear MP650 (30).

(10) Remove the two 6-32 x ½-inch machine screws (41) and synchro clamps H602-2 (40) and then remove synchro control transformer B602 from the gear housing plate.

(11) Remove the two 6-32 x ½-inch machine screws (36) and servo motor clamps H602-1 (35) and then remove servo motor B603 (37) and servo motor shield A 615 (42) from the gear housing plate.

b. Before reassembly, be sure the parts are carefully cleaned. Clean with a cloth moistened in Cleaning Compound and dry with a lint-free cloth. Replace any damaged parts if replacement parts are available. Reassemble the parts of the deflection coil as they were disassembled, following the sequence given below:

(1) Mount servo motor B603 (37), servo motor shield A 615 (42), and synchro control transformer B602 (39) on the gear housing plate (32); use the four 6-32 x ½-inch machine screws (36 and 41) and clamps H602-1 and H602-2 (35 and 40).

(2) Install spur gear MP650 (30) on the shaft of synchro control transformer B602 (39); use the washer (29) and 10-32 nut (28).

(3) Push ball bearing MP620 (19) in place and secure it with the retaining ring (18).

(4) Push ball bearing MP617 (24) in the gear housing. Install ball bearings MP618 (26) and MP619 (31) in the gear housing plate (32).

(5) Install gear assembly MP 607 (22) in the gear housing with ball bearing MP620 (19).

(6) Replace gear assembly MP606 (25) into ball bearing MP617 (24). Be sure all gears mesh properly.

(7) Lightly oil the gear-tooth surfaces with Grease, Aircraft and Instruments (GL) (MIL-G-3278).

(8) Assemble the gear housing plate (32) to the gear housing (21). Two dowel pins (33 and 38) assure proper alignment of the two parts of the gear housing. Check for smooth-running gears. Secure the two parts of the housing together with the three 8-32 x $\frac{5}{8}$-inch screws (34).

(9) Mount the completely assembled gear housing on to the base (12) and fasten it with the three 8-32 x $\frac{5}{8}$-inch machine screws and lock washers (8 and 14).

(10) Install spur gear MP649 (7) on the projecting shaft. To secure the gear on the shaft, tighten the two screws (6) at the hub.

(11) Install coil and gear assembly E635 (1 through 5) onto the base (12). This is secured by three ball bearings MP614 (9) and bushings MP655 (10) that are secured by three machine screws (11).

(12) Check for proper mesh of gears and free rotation of the gear train and the coil and gear assembly.

(13) Refer to figure 21 for lubrication instructions.

(14) Attach brush block MP605 and contacts E629 and E631 (15, 16, and 17) to base A 602 (12), use the lock washer (14) and machine screw (13). Be sure the contacts align properly with the slip rings on the coil and gear assembly.

(15) Reinstall the cathode-ray tube as outlined in paragraph 72.

LEGEND FOR FIGURE 57

1. Gear ring, part of E635.
2. Coil and shield, part of E635.
3. Nylon washer, part of E635.
4. Flat washer #6, part of E635.
5. Machine screw 6-32 x 5/8 inch.
6. Machine screws 4-40 x 7/16 inch.
7. Spur gear (MP649).
8. Machine screw 8-32 x 5/8 inch.
9. Ball bearing (MP614).
10. Bushing (MP655).
11. Machine screw 8-32 x 5/8 inch.
12. Base (A 602).
13. Machine screw 8-32 x 1/2 inch.
14. Lock washer #8.
15. Brush block (MP604).
16. Contact (E629).
17. Contact (E631).
18. Retaining ring.
19. Ball bearing (MP620).
20. Button plug (H616).
21. Gear housing.
22. Gear assembly (MP607).
23. Lock-pin, part of MP607.
24. Ball bearing (MP617).
25. Gear assembly (MP606).
26 Ball bearing (MP618).
27. Lock pin (MP613), part of MP606.
28. Nut 10-32.
29. Washer #10.
30. Spur gear (MP650).
31. Ball bearing (MP619).
32. Gear housing plate.
33. Dowell pin 1/8 inch x 13/32 inch.
34. Machine screw 8-32 x 5/8 inch.
35. Servo motor clamp (H602-1).
36. Machine screw 6-32 x 1/2 inch.
37. Servo motor (B603).
38. Dowel pin 1/8 inch x 13/32 inch.
39. Synchro control transformer (B602).
40. Synchro motor clamp (H602-2).
41. Machine screw 6-32 x 1/2 inch.
42. Servo motor shield (A 615).

Figure 57. Deflection coil drive assembly, exploded view.

CHAPTER 7
SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

78. Disassembly

Disassemble Azimuth and Range Indicator IP-345/TPS-1D prior to packing for shipment or limited storage.

a. Disconnect all plugs of interconnecting cables.

b. Remove the cathode-ray tube (par. 72).

79. Repacking for Shipment or Limited Storage

The exact procedure for repacking depends upon the material available and the conditions under which the equipment is to be shipped or stored. General information concerning the original packaging (par. 5) may be helpful.

a. Preparation.

(1) Coil and tie all cables and cover ends with suitable protective covering.

(2) Be sure all electron tubes are firmly seated in their sockets.

b. Packing.

(1) Pack the cathode-ray tube separately in a suitable padded container.

(2) Stow all spare parts and the spare azimuth dial in a padded container. Fill all voids with packing material to prevent movement and possible breakage.

(3) Pack the cables in a suitable container.

(4) Pack the running spares package and the viewing hood inside the cover. Tape or tie the packages securely in place.

(5) Pack the remote ppi, cathode-ray tube, and cables in a suitable wooden box. Cushion all surfaces of the unit and bolt it to the bottom of the case. Use wadding or corrugated paper to cushion each package as required.

(6) Mark the shipping container in accordance with the requirements of SR-720-1.

Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

80. Authority for Demolition

Demolition of the equipment will be accomplished only upon the order of the commander. Use as many of the demolition procedures outlined in paragraph 81 as are necessary to prevent the enemy from using or salvaging the equipment.

81. Methods of Destruction

a. Smash. Smash the controls, tubes, coils, switches, capacitors, transformers, and meter; use sledges, axes, handaxes, pickaxes, hammers, crowbars, or heavy tools.

b. Cut. Cut the output and power cord and slash the rf shield; use axes, handaxes, or machetes.

c. Burn. Burn cords and technical manuals; use gasoline, kerosene, oil, flame throwers, or incendiary grenades.

d. Bend. Bend panel and cabinet.

e. Explosives. If explosives are necessary, use firearms, grenades, or TNT.

f. Disposal. Bury or scatter the destroyed parts in slit trenches, fox holes, or throw them into streams.

CHAPTER 7
SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

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(2) Stow all spare parts and the spare azimuth dial in a padded container. Fill all voids with packing material to prevent movement and possible breakage.

(3) Pack the cables in a suitable container.

(4) Pack the running spares package and the viewing hood inside the cover. Tape or tie the packages securely in place.

(5) Pack the remote ppi, cathode-ray tube, and cables in a suitable wooden box. Cushion all surfaces of the unit and bolt it to the bottom of the case. Use wadding or corrugated paper to cushion each package as required.

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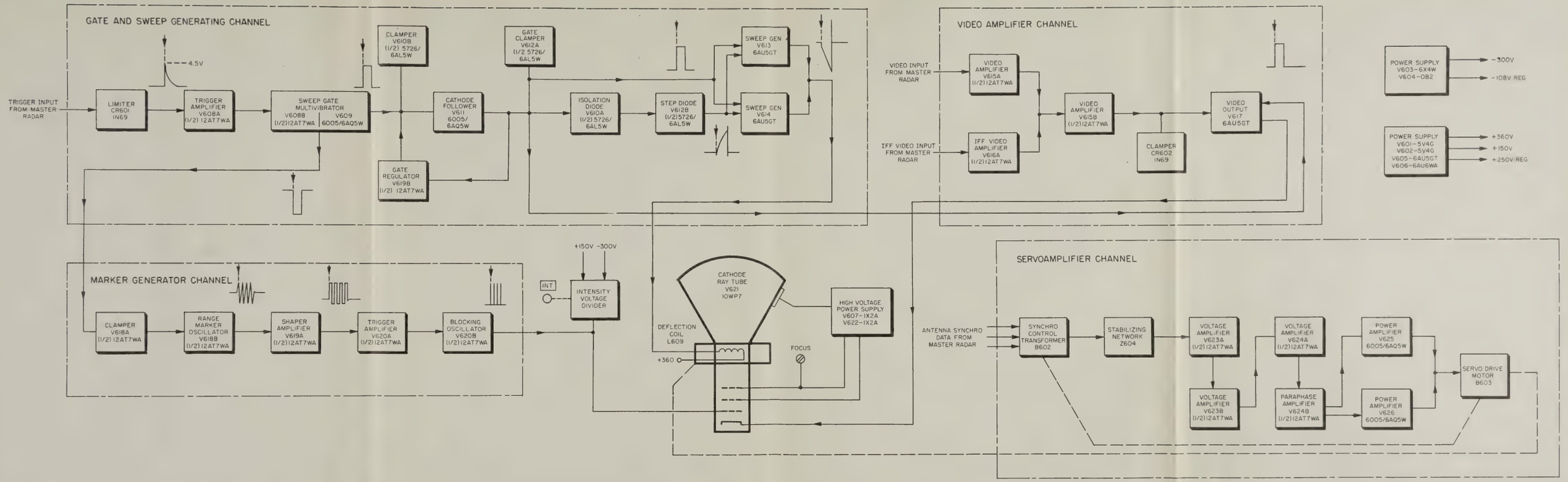


Figure 58. Azimuth and Range Indicator IP-345/TPS-1D, block diagram.

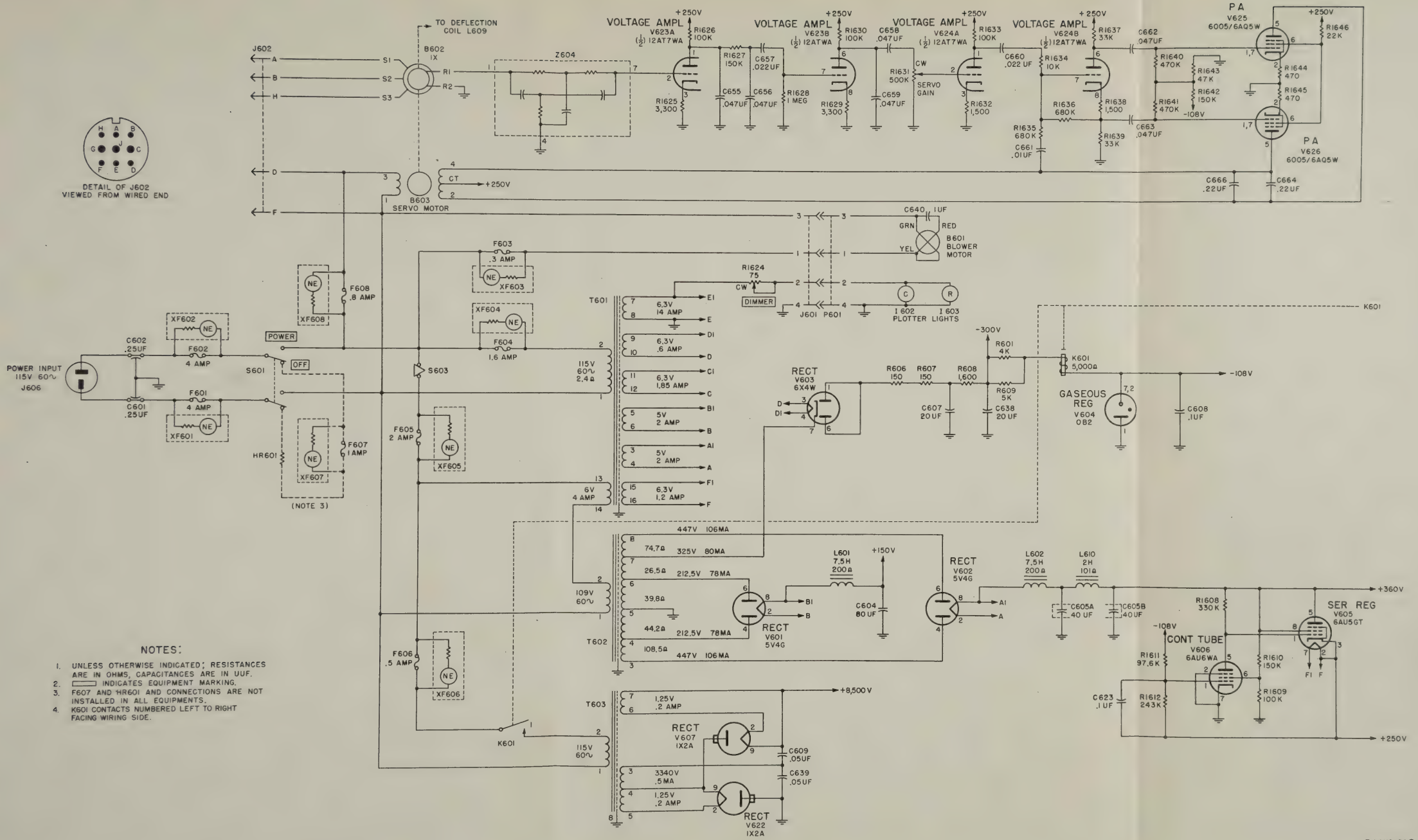


Figure 59. Azimuth and Range Indicator IP345/TPS-1D, schematic diagram.

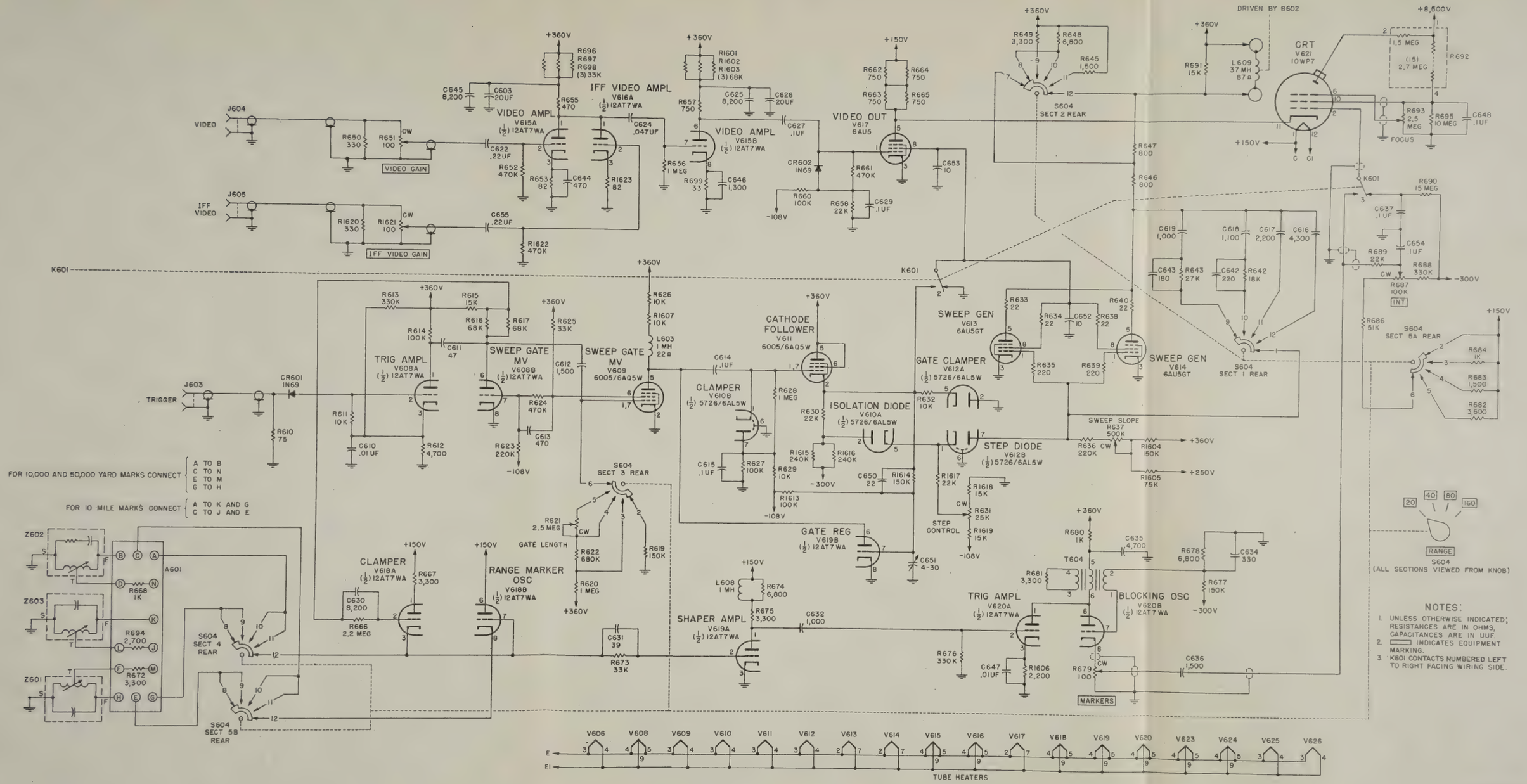


Figure 59—Continued.

PARTS LOCATION KEY FOR FIGURE 60, PARTS 1 and 2.

Notes. 1. Vertical index numbers 1-21 appear on Part 1. 2. Vertical index numbers 22 and above appear on Part 2.

Symbol	*Location*
B601	B-28
B602	C-28
B603	C-23
C601	D- 1
C602	E- 1
C603	A- 3
C604	D-12
C605	B-12
C607	D-12
C608	B-11
C609	B-14
C610	H-11
C611	E-10
C612	F-10
C613	F- 9
C614	D-10
C615	G-11
C616	G-17
C617	F-16
C618	G-16
C619	G-16
C622	B- 5
C623	B- 8
C624	C- 4
C625	C- 3
C626	B- 3
C627	D- 3
C629	C- 4
C630	G- 9
C631	F- 8
C632	E- 7
C634	F- 6
C635	E- 5
C636	B-15
C637	A-10
C638	C-12
C639	B-13
C640	A-28
C642	F-16
C643	G-16
C644	A- 4
C645	B- 3
C646	B- 4
C647	G- 6
C648	B-12
C650	G- 9
C651	E- 7
C652	E-13
C653	C- 3
C654	C-14
C655	G-25
C656	G-25
C657	G-26
C658	E-26
C659	G-26
C660	F-27
C661	G-28
C662	E-28
C663	H-28
C664	F-30
C665	D- 5
C666	F-31
CR601	G-11
CR602	B- 5
F622	F-14
FT#1	E-24
FT#2	E-24
FT#3	E-24
FT#4	E-25
FT#5	E-29
FT#6	E-30
FT#7	G-30
HR601	D-17
J601	A- 6
J602	D- 1
J603	E- 1
J604	F- 1
J605	F- 1
J606	A- 1
K601	C-20
L601	E-18
L602	C-18
L603	E- 9
L608	H- 8
L609	D-24
L610	D-11
P601	B-26
R601	B-10
R606	B-11
R607	B-11
R608	B-10
R609	B- 9
R610	G-11
R611	F-10
R612	F-10
R613	H- 9
R614	G-10
R615	G-10
R616	H-10
R617	H- 9
R619	F-14
R620	F-14
R621	E-17
R622	G-14
R623	G- 9
R624	F-10
R625	E- 8
R626	E- 8
R627	E-10
R628	E-10
R629	G-11
R630	E-11
R631	E-12
R632	F-11
R633	E-14
R634	E-13
R635	E-14
R636	E-16
R637	E-16
R638	E-14
R639	E-15
R640	E-15
R642	F-16
R643	G-16
R645	G-15
R646	D-14
R647	C-14
R648	G-15
R649	F-15
R650	E-21
R651	E-21
R652	A- 3
R653	A- 4
R654	C- 6
R656	A- 3
R657	C- 6
R658	C- 3
R660	C- 6
R661	B- 5
R662	D- 6
R663	B- 5
R664	D- 6
R665	C- 5
R666	G-10
R667	G- 8
R668	F- 3
R672	E- 3
R673	F- 8
R674	G- 8
R675	G- 8
R676	E- 6
R677	E- 6
R678	E- 6
R679	B-20
R680	E- 5
R681	F- 5
R682	F-12
R683	F-13
R684	F-12
R686	F-13
R687	B-18
R688	A-10
R689	B-14
R690	A-10
R691	D-24
R692	B-18
R693	B-13
R694	E- 3
R695	B-12
R696	A- 8
R697	A- 8
R698	A- 8
R699	B- 4
R1601	A- 9
R1602	A- 9
R1603	A- 9
R1604	E-16
R1605	E-16
R1606	F- 6
R1607	E- 8
R1608	C- 9
R1609	C- 8
R1610	C- 9
R1611	D- 9
R1612	C- 8
R1613	H- 8
R1614	G- 9
R1615	C-15
R1616	C-15
R1617	E-12
R1618	F-12
R1619	G-12
R1620	F-21
R1621	F-21
R1622	C- 3
R1623	C- 3
R1624	A-20
R1625	F-25
R1626	F-25
R1627	G-25
R1628	G-26
R1629	G-26
R1630	E-25
R1631	F-27
R1632	E-27
R1633	F-27
R1634	G-28
R1635	G-28
R1636	G-28
R1637	E-27
R1638	G-28
R1639	G-28
R1640	F-30
R1641	F-30
R1642	F-30
R1643	F-30
R1644	E-27
R1645	F-29
R1646	G-30
S601	D-20
S603	A- 4
S604 (1)	G-16
S604 (2)	F-16
S604 (3)	G-15
S604 (4)	F-15
S604 (5)	G-13
S604 (6)	F-13
T601	G-18
T602	D-18
T603	B-18
T604	F- 5
TP#1	B- 6
TP#2	C- 6
TP#3	E- 4
TP#4	E- 4
TP#5	F- 4
TP#8	A-27
TP#11	E-16
TP#12	E-16
XF601	C- 2
XF602	C- 2
XF603	B- 2
XF604	B- 2
XF605	C- 1
XF606	B- 1
XF607	B- 1
XF608	A- 1
XI602	E-23
XI603	F-23
XV601	B-11
XV602	B- 8
XV603	C-11
XV604	B-10
XV605	B- 9
XV606	D- 8
XV607	B-15
XV608	F-10
XV609	E- 9
XV610	E-10
XV611	E-11
XV612	F-11
XV613	E-14
XV614	E-15
XV615	A- 4
XV616	C- 4
XV617	B- 4
XV618	F- 9
XV619	F- 7
XV620	F- 6
XV621	D- 3
XV622	B-14
XV623	F-25
XV624	F-27
XV625	E-29
XV626	G-29
Z601	G- 6
Z602	G- 5
Z603	G- 4
Z604	F-24

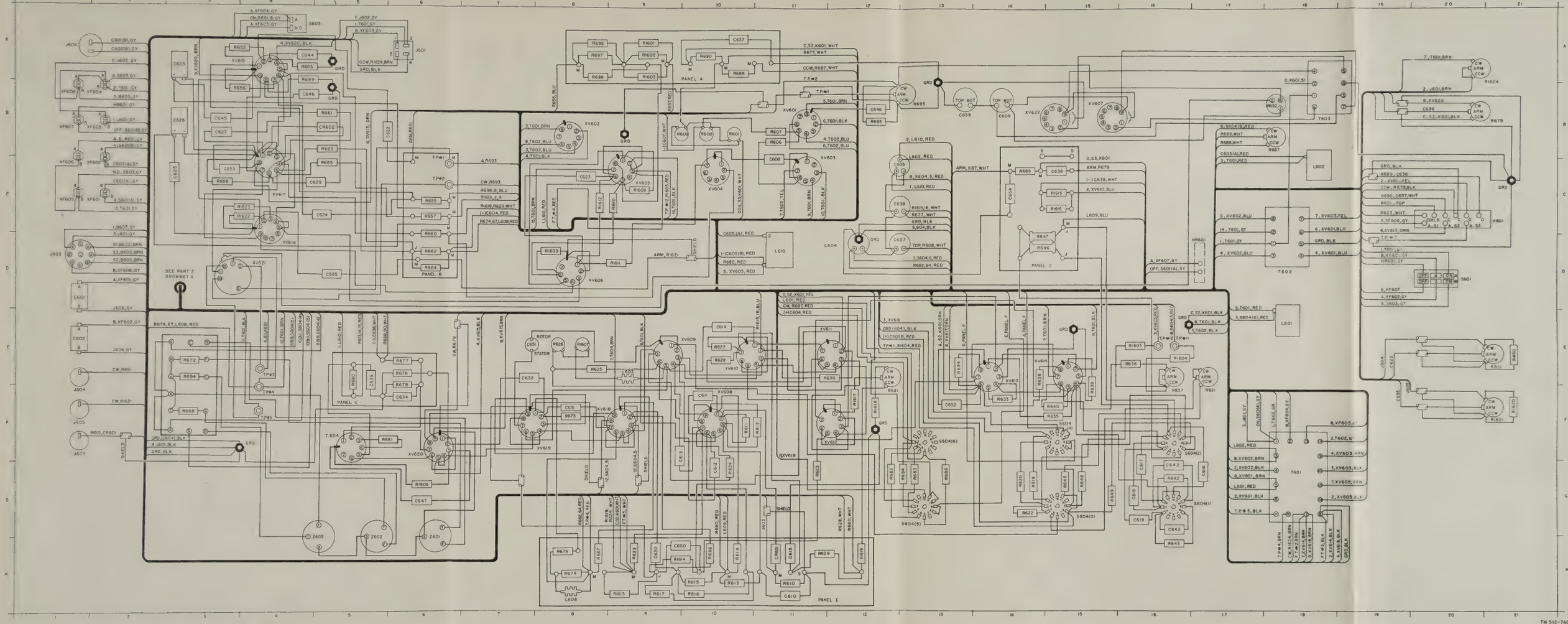


Figure 60. Azimuth and Range Indicator IP-345/TPS-1D, practical wiring diagram.

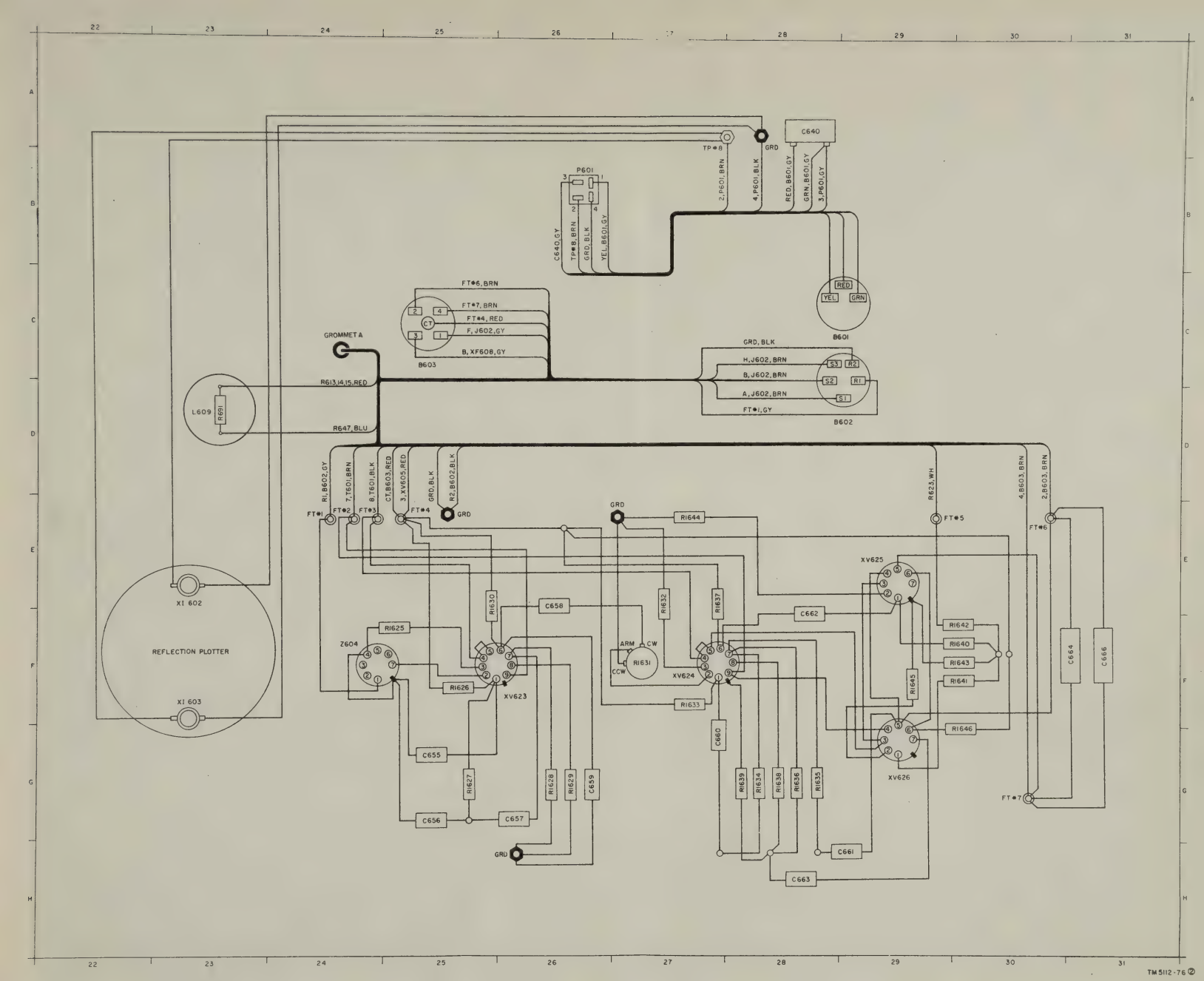
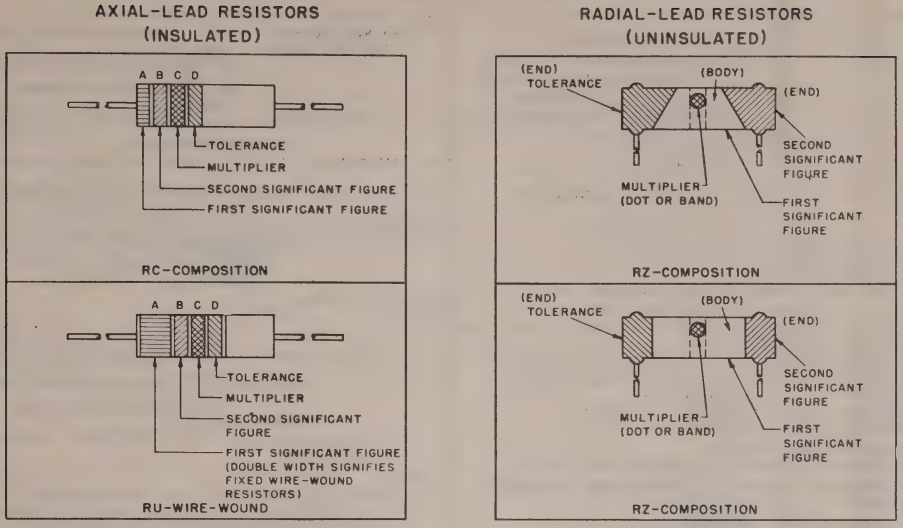


Figure 60—Continued.

RESISTOR COLOR CODE MARKING
(MIL-STD RESISTORS)



RESISTOR COLOR CODE

BAND A OR BODY*		BAND B OR END*		BAND C OR DOT OR BAND*		BAND D OR END*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1	BODY	± 20
BROWN	1	BROWN	1	BROWN	10	SILVER	± 10
RED	2	RED	2	RED	100	GOLD	± 5
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000		
GREEN	5	GREEN	5	GREEN	100,000		
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	GOLD	0.1		
WHITE	9	WHITE	9	SILVER	0.01		

* FOR WIRE-WOUND-TYPE RESISTORS, BAND A SHALL BE DOUBLE-WIDTH. WHEN BODY COLOR IS THE SAME AS THE DOT (OR BAND) OR END COLOR, THE COLORS ARE DIFFERENTIATED BY SHADE, GLOSS, OR OTHER MEANS.

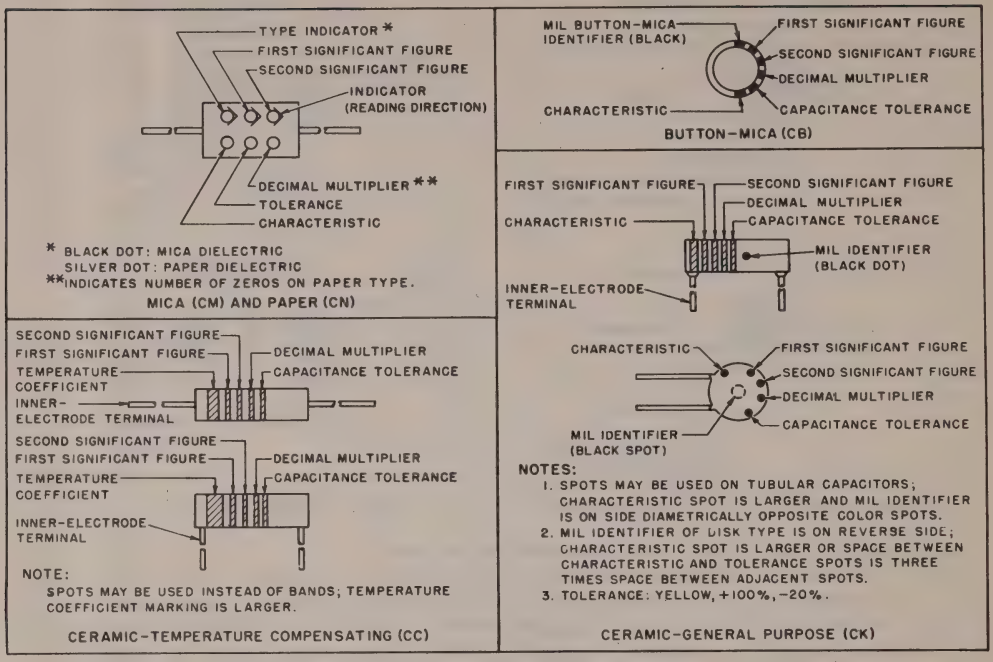
EXAMPLES (BAND MARKING):
10 OHMS ±20 PERCENT: BROWN BAND A; BLACK BAND B; BLACK BAND C; NO BAND D.
4.7 OHMS ±5 PERCENT: YELLOW BAND A; PURPLE BAND B; GOLD BAND C; GOLD BAND D.

EXAMPLES (BODY MARKING):
10 OHMS ±20 PERCENT: BROWN BODY; BLACK END; BLACK DOT OR BAND; BODY COLOR ON TOLERANCE END.
3,000 OHMS ±10 PERCENT: ORANGE BODY; BLACK END; RED DOT OR BAND; SILVER END.

STD-R1

Figure 61. Resistor color code.

CAPACITOR COLOR CODE MARKING
(MIL-STD CAPACITORS)



CAPACITOR COLOR CODE

COLOR	SIG FIG.	MULTIPLIER		CHARACTERISTIC[1]				TOLERANCE [2]					TEMPERATURE COEFFICIENT (UUF/UF/°C)
		DECIMAL	NUMBER OF ZEROS	CM	CN	CB	CK	CM	CN	CB	CC		
											OVER 10UUF	10UUF OR LESS	CC
BLACK	0	1	NONE		A			20	20	20	20	2	ZERO
BROWN	1	10	1	B	E	B	W				1		-30
RED	2	100	2	C	H		X	2		2	2		-80
ORANGE	3	1,000	3	D	J	D			30				-150
YELLOW	4	10,000	4	E	P								-220
GREEN	5		5	F	R						5	0.5	-330
BLUE	6		6		S								-470
PURPLE (VIOLET)	7		7		T	W							-750
GRAY	8		8			X						0.25	+30
WHITE	9		9								10	1	-330(±500) [3]
GOLD		0.1						5		5			+100
SILVER		0.01						10	10	10			

1. LETTERS ARE IN TYPE DESIGNATIONS GIVEN IN MIL-C SPECIFICATIONS.
2. IN PERCENT, EXCEPT IN UUF FOR CC-TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION.

STD-CI

Figure 62. Capacitor color code.

A

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DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C., 17 January 1956.

TM 11-5112 is published for the use of all concerned.

By Order of *Wilber M. Brucker*, Secretary of the Army:

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For explanation of abbreviations used, see SR 320-50-1.